US005530470A

United States Patent [19]

Yoshida et al.

[11] **Patent Number: 5,530,470**

[45] **Date of Patent: Jun. 25, 1996**

[54] **RECORDING APPARATUS WITH CONTROLLED THERMAL TRANSFER ENERGY**

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[73] Assignee: **Canon Kabushiki Kaisha**, Tokyo, Japan

[21] Appl. No.: **55,349**

[22] Filed: **May 3, 1993**

Related U.S. Application Data

[62] Division of Ser. No. 775,122, Oct. 11, 1991.

[30] **Foreign Application Priority Data**

Oct. 17, 1990	[JP]	Japan	2-276523
Oct. 17, 1990	[JP]	Japan	2-276524
Dec. 26, 1990	[JP]	Japan	2-406813

[51] **Int. Cl.**[6] **B41J 2/36**

[52] **U.S. Cl.** **347/190**; 358/296

[58] **Field of Search** ..... 358/296; 346/76 PH; 400/223, 226.1, 226.2, 225, 232, 120, 120.09, 120.1; 347/188, 190

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,712,115	12/1987	Tatsumi et al.	346/76 PH
4,814,789	3/1989	Ono	346/76 PH
4,875,056	10/1989	Ono	346/76 PH
4,967,205	10/1990	Sakaguchi et al.	346/76 PH
5,122,882	6/1992	Ishida et al.	358/296
5,144,329	9/1992	Takeda et al.	346/1.1
5,177,499	1/1993	Yoshida et al.	346/76 PH
5,179,390	1/1993	Yokoyama et al.	346/76 PH
5,184,151	2/1993	Ono et al.	346/76 PH
5,187,494	2/1993	Ono et al.	346/76 PH
5,193,007	3/1993	Yokoyama et al.	358/296
5,204,692	4/1993	Awai et al.	346/76 PH
5,206,661	4/1993	Terajima et al.	346/76 PH
5,293,530	3/1994	Yoshida et al.	346/76 PH

FOREIGN PATENT DOCUMENTS

0156360	10/1985	European Pat. Off.	400/120
0086782	7/1981	Japan	346/76 PH
57-83471	5/1982	Japan .	
62-58917	1/1983	Japan .	
58-201686	11/1983	Japan .	
0076363	4/1985	Japan	400/120

Primary Examiner—Huan H. Tran
Attorney, Agent, or Firm—Fitzpatrick, Cella, Harper & Scinto

[57] **ABSTRACT**

A thermal transfer recording apparatus for performing the recording an image on a recording medium by transferring ink contained in an ink sheet to the recording medium has ink sheet a conveyance unit for conveying the ink sheet, a recording medium conveyance unit for conveying the recording medium, a recording unit for recording an image on the recording medium by activating the ink sheet, a counting unit for counting the black dot numbers in the current line, a timing unit for measuring the elapsed time since the image recording in the last line by the recording unit, and a control unit for controlling the ink sheet to be conveyed for a predetermined length without conveying the recording medium in accordance with the timing value of the timing unit and the counting value of the counting unit subsequent to the current line recording by the recording, thus making it possible to separate the ink sheet and recording sheet more reliably to maintain a high recording quality.

12 Claims, 22 Drawing Sheets

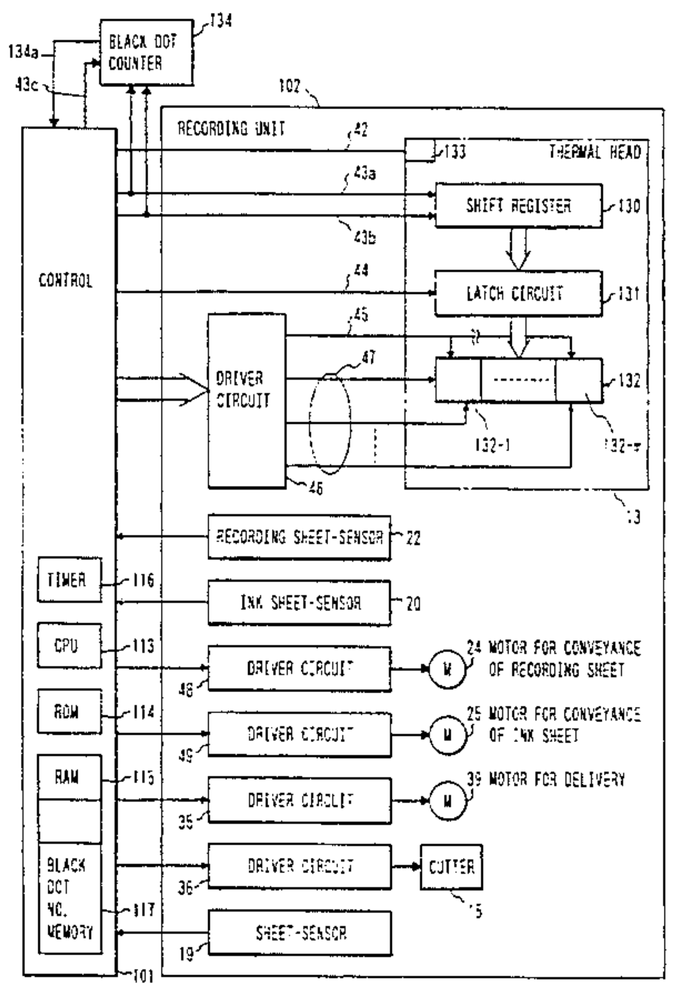


FIG. 1

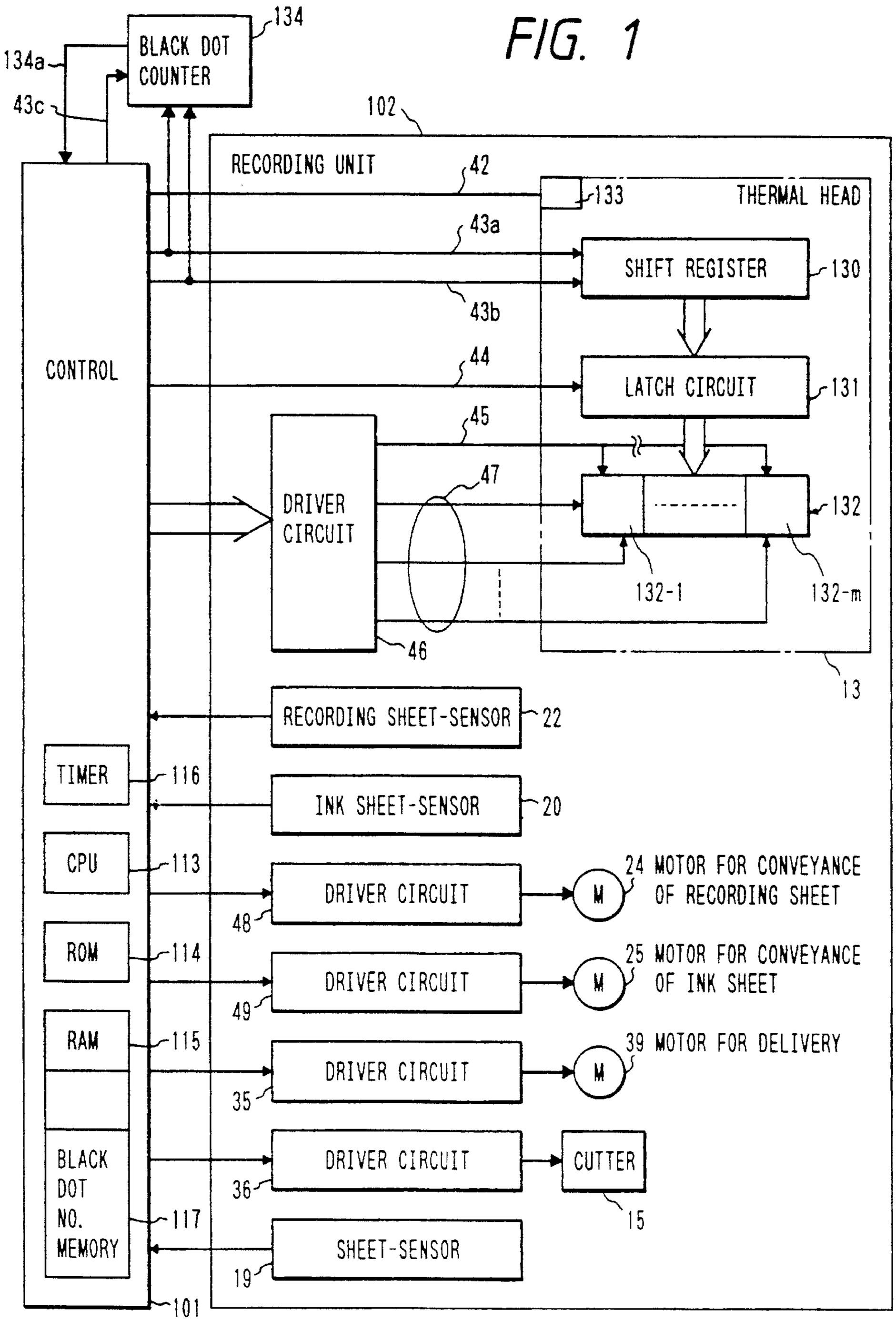

BLACK DOT COUNTER
134
134a
43c
102
RECORDING UNIT
42
133
THERMAL HEAD
43a
43b
SHIFT REGISTER
130
CONTROL
44
LATCH CIRCUIT
131
45
47
DRIVER CIRCUIT
132
132-1
132-m
46
13
RECORDING SHEET-SENSOR
22
TIMER
116
INK SHEET-SENSOR
20
CPU
113
DRIVER CIRCUIT
24 MOTOR FOR CONVEYANCE OF RECORDING SHEET
M
48
ROM
114
DRIVER CIRCUIT
25 MOTOR FOR CONVEYANCE OF INK SHEET
M
49
RAM
115
DRIVER CIRCUIT
39 MOTOR FOR DELIVERY
M
35
BLACK DOT NO. MEMORY
117
DRIVER CIRCUIT
CUTTER
36
15
SHEET-SENSOR
19
101

FIG. 2

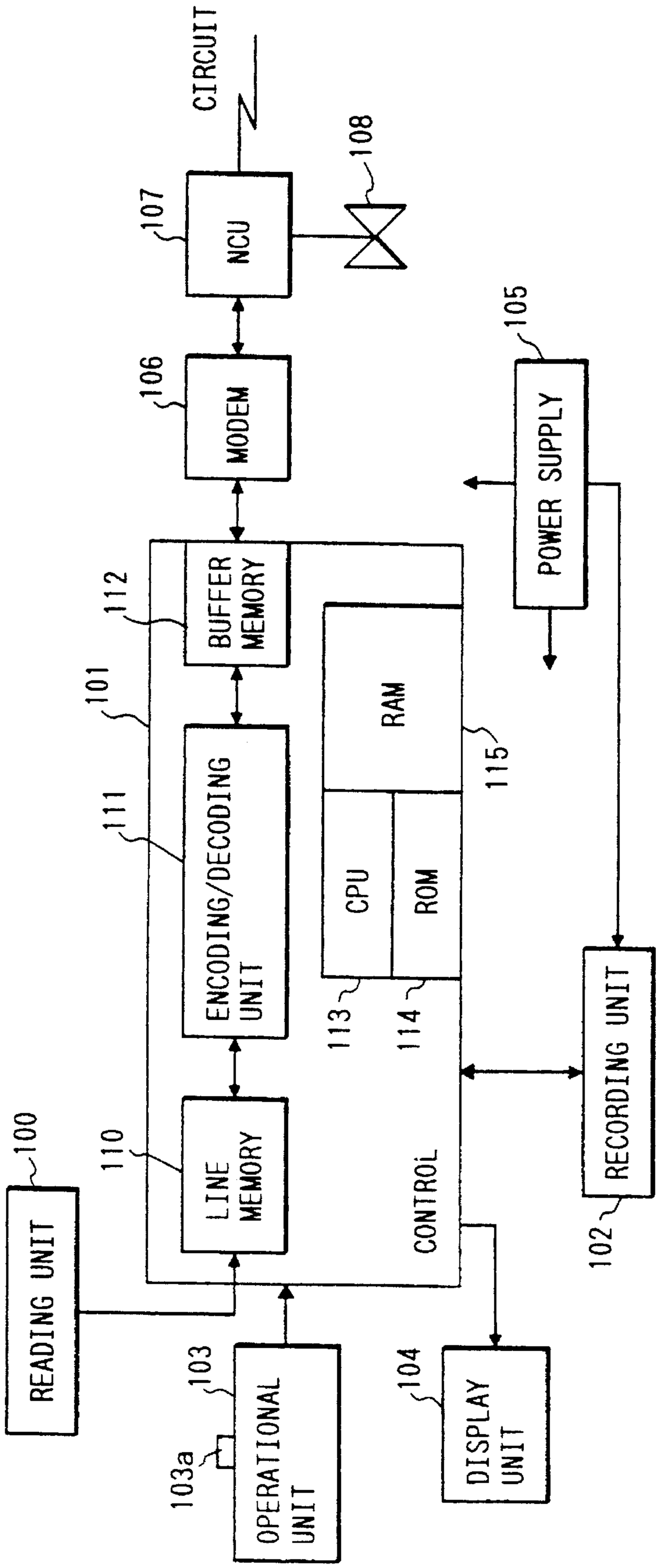

READING UNIT
100
LINE MEMORY
110
ENCODING/DECODING UNIT
111
BUFFER MEMORY
112
MODEM
106
CIRCUIT
NCU
107
108
OPERATIONAL UNIT
103
103a
DISPLAY UNIT
104
CONTROL
CPU
113
ROM
114
RAM
115
POWER SUPPLY
105
RECORDING UNIT
102
101

FIG. 3

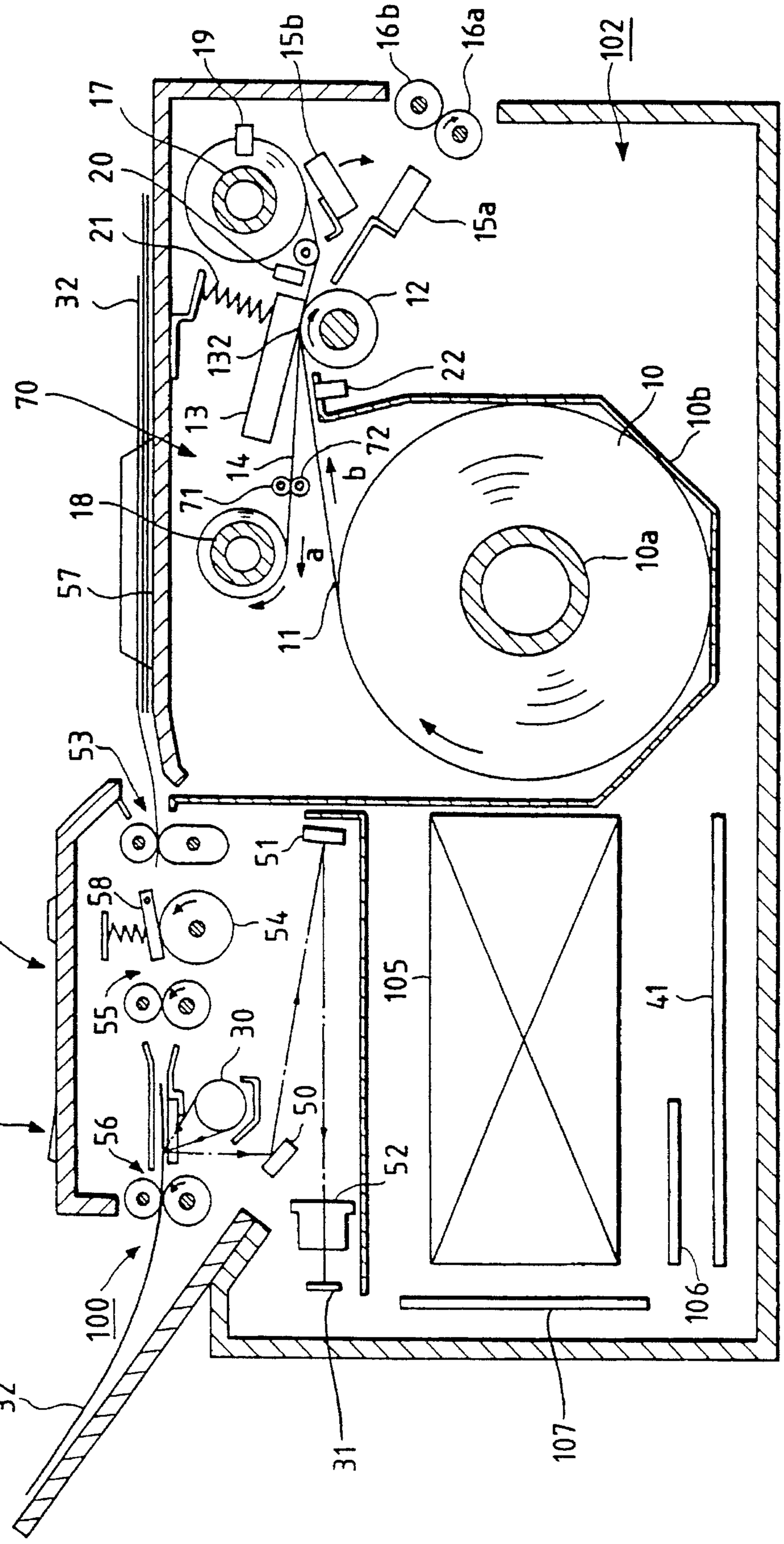

19
15b
16b
16a
102
17
20
21
15a
32
12
132
22
70
13
10
10b
14
72
b
71
18
a
10a
57
11
53
51
58
54
103
105
41
55
30
104
56
50
52
100
106
32
31
107

FIG. 4

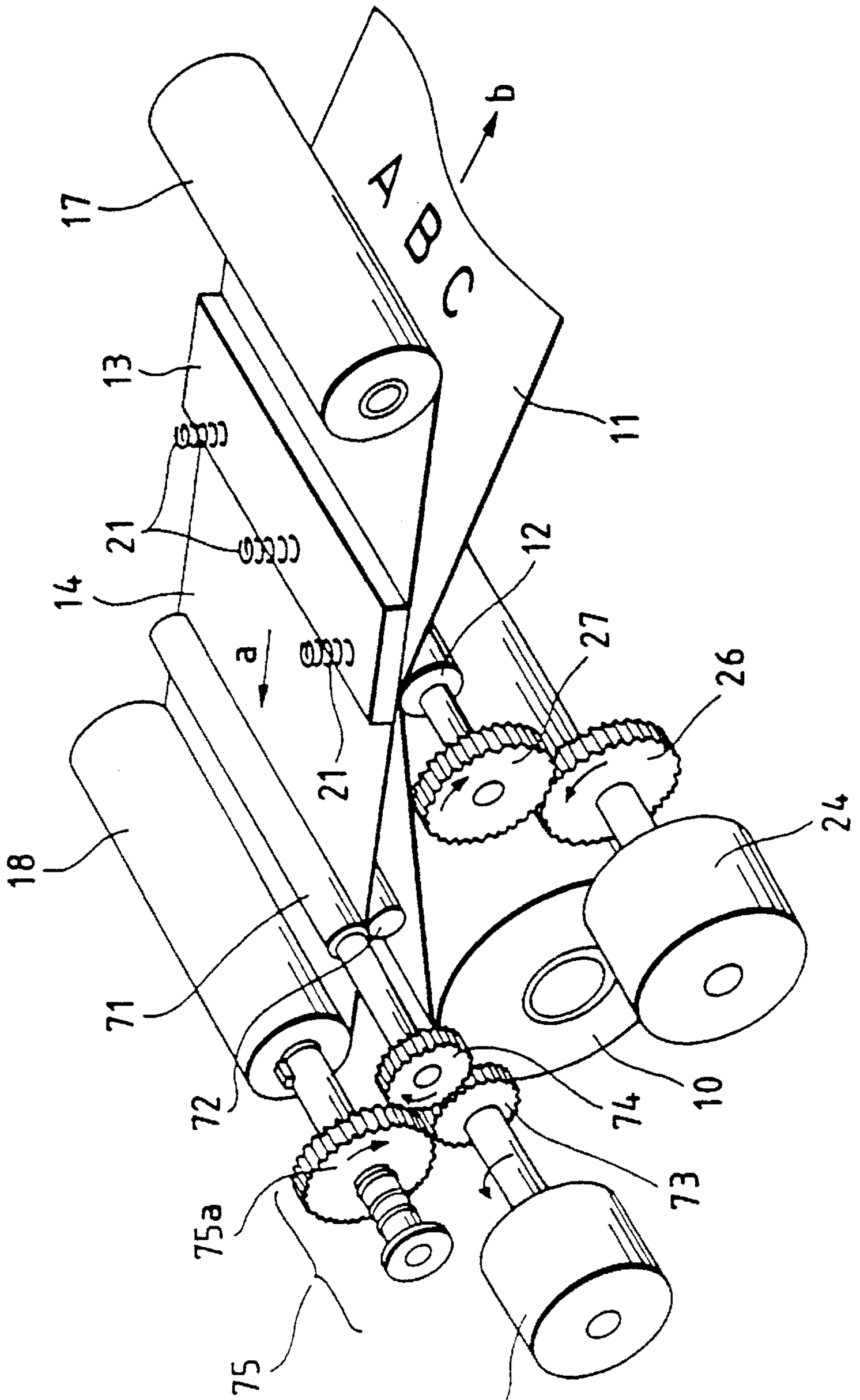


FIG. 5A

FIG. 5A-1
FIG. 5A-2

FIG. 5A-1

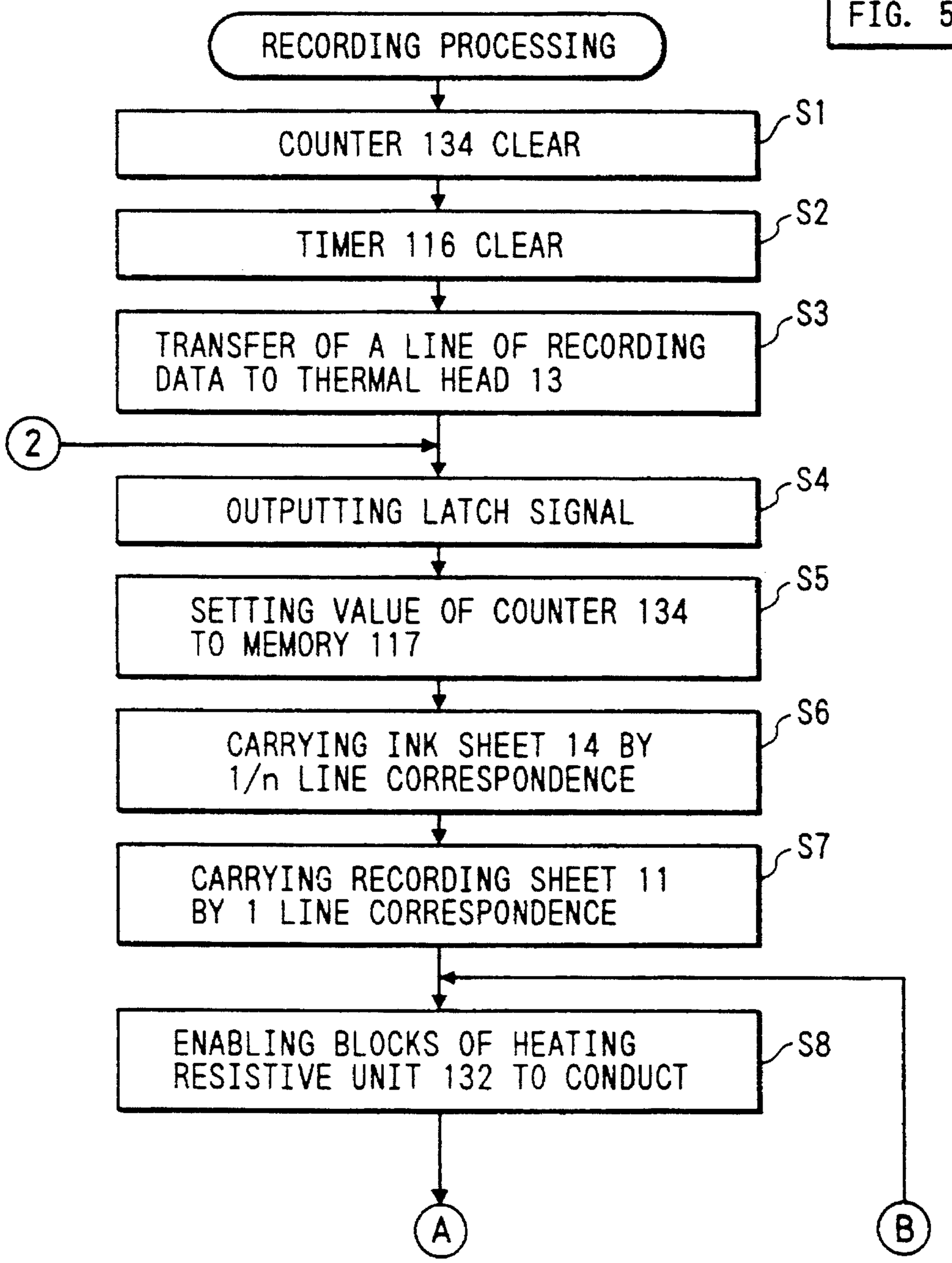


FIG. 5A-2

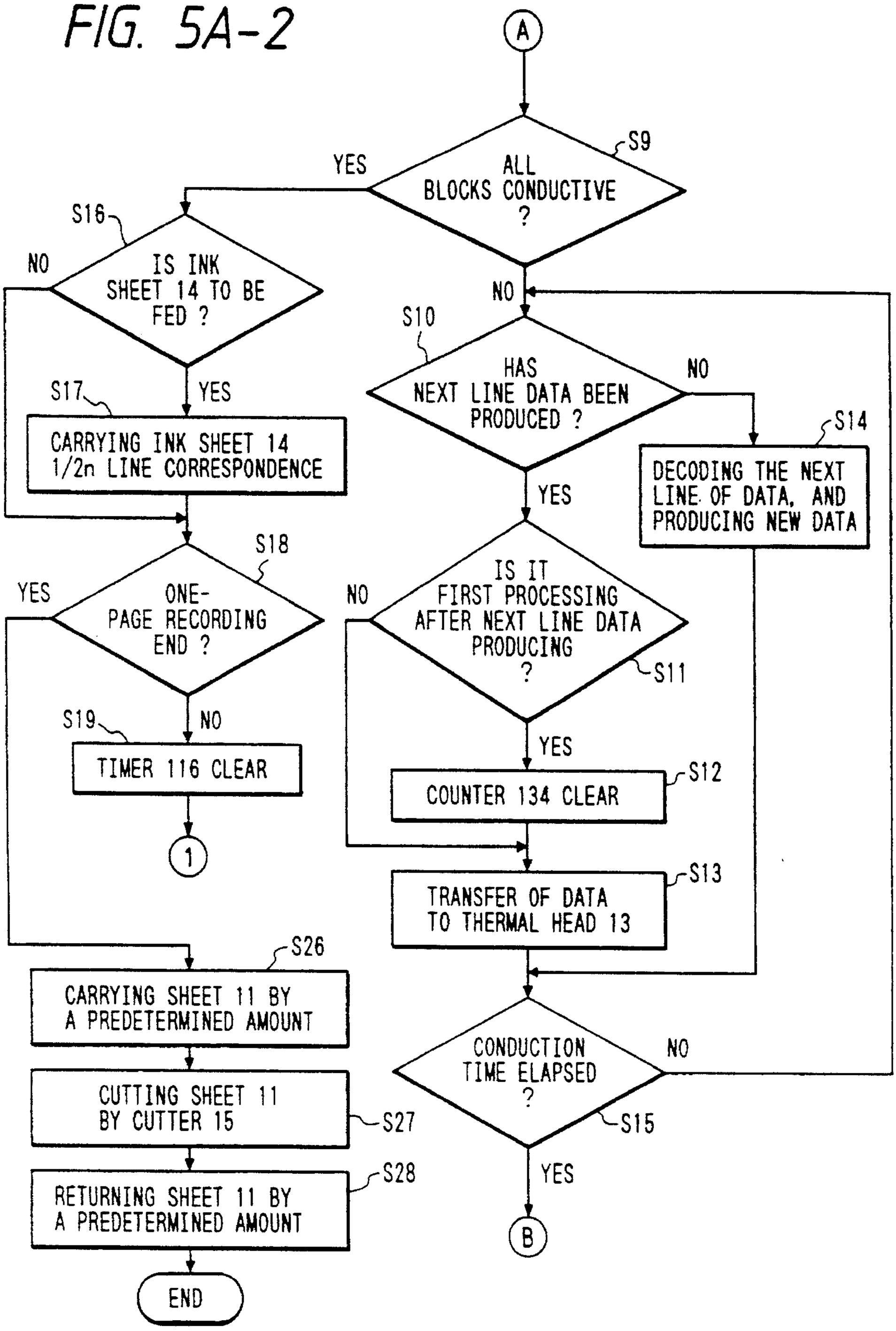

A
S9
ALL BLOCKS CONDUCTIVE ?
YES
NO
S16
IS INK SHEET 14 TO BE FED ?
NO
YES
S17
CARRYING INK SHEET 14 1/2n LINE CORRESPONDENCE
S10
HAS NEXT LINE DATA BEEN PRODUCED ?
NO
YES
S14
DECODING THE NEXT LINE OF DATA, AND PRODUCING NEW DATA
S18
ONE-PAGE RECORDING END ?
YES
NO
IS IT FIRST PROCESSING AFTER NEXT LINE DATA PRODUCING ?
S11
YES
NO
S19
TIMER 116 CLEAR
1
S12
COUNTER 134 CLEAR
S13
TRANSFER OF DATA TO THERMAL HEAD 13
S26
CARRYING SHEET 11 BY A PREDETERMINED AMOUNT
CUTTING SHEET 11 BY CUTTER 15
S27
S28
RETURNING SHEET 11 BY A PREDETERMINED AMOUNT
END
CONDUCTION TIME ELAPSED ?
NO
S15
YES
B

FIG. 5B

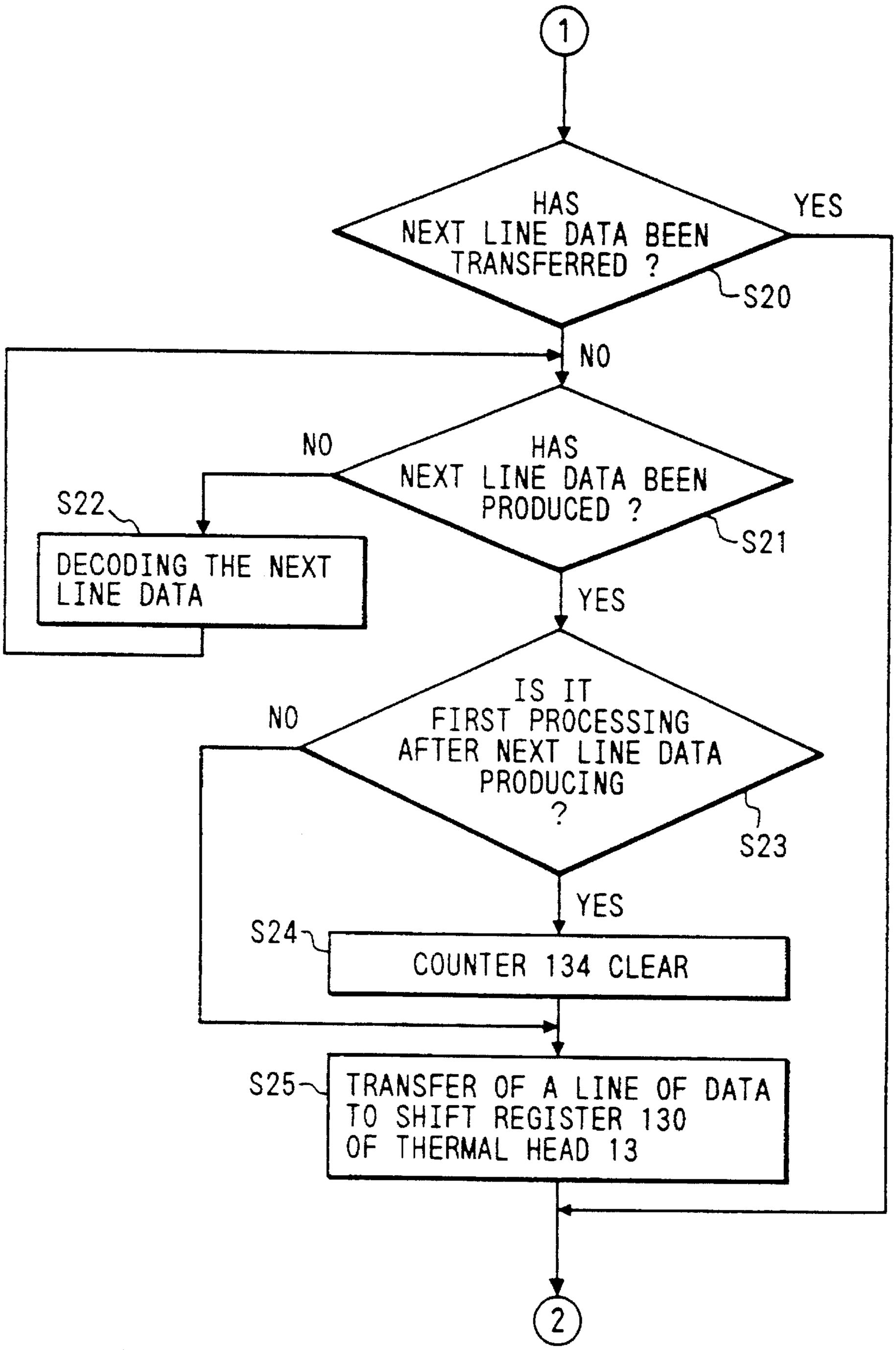

1
HAS NEXT LINE DATA BEEN TRANSFERRED ?
YES
S20
NO
HAS NEXT LINE DATA BEEN PRODUCED ?
NO
S21
S22
DECODING THE NEXT LINE DATA
YES
IS IT FIRST PROCESSING AFTER NEXT LINE DATA PRODUCING ?
NO
S23
YES
S24
COUNTER 134 CLEAR
S25
TRANSFER OF A LINE OF DATA TO SHIFT REGISTER 130 OF THERMAL HEAD 13
2

FIG. 5C

RECORDING PERIOD (ms)	BLACK RATE AT B4	NO. OF DOTS
$0 \leqq t \leqq 30$	NO	NO
$30 < t \leqq 40$	ABOVE 90%	ABOVE 1843
$40 < t \leqq 60$	ABOVE 65%	ABOVE 1331
$60 < t \leqq 250$	ABOVE 75%	ABOVE 1536
$250 < t \leqq 500$	ABOVE 50%	ABOVE 1024
$500 < t$	ABOVE 25%	ABOVE 512

FIG. 8C

VALUE OF CURRENT RECORDED LINE INFORMATION (ie VALUE OF BLKCOUNT)

RECORDING PERIOD (ms)	BLACK RATE AT B4	NO. OF DOTS
$0 \leqq t \leqq 30$	NO	NO
$30 < t \leqq 40$	ABOVE 90%	ABOVE 1843
$40 < t \leqq 60$	ABOVE 65%	ABOVE 1331
$60 < t \leqq 250$	ABOVE 75%	ABOVE 1536
$250 < t \leqq 500$	ABOVE 50%	ABOVE 1024
$500 < t$	ABOVE 25%	ABOVE 512

OR IN CASE THAT CONDITION:
(MEMORY 117) - (MEMORY 118) $\geqq$ 512 IS SATISFIED

FIG. 5D

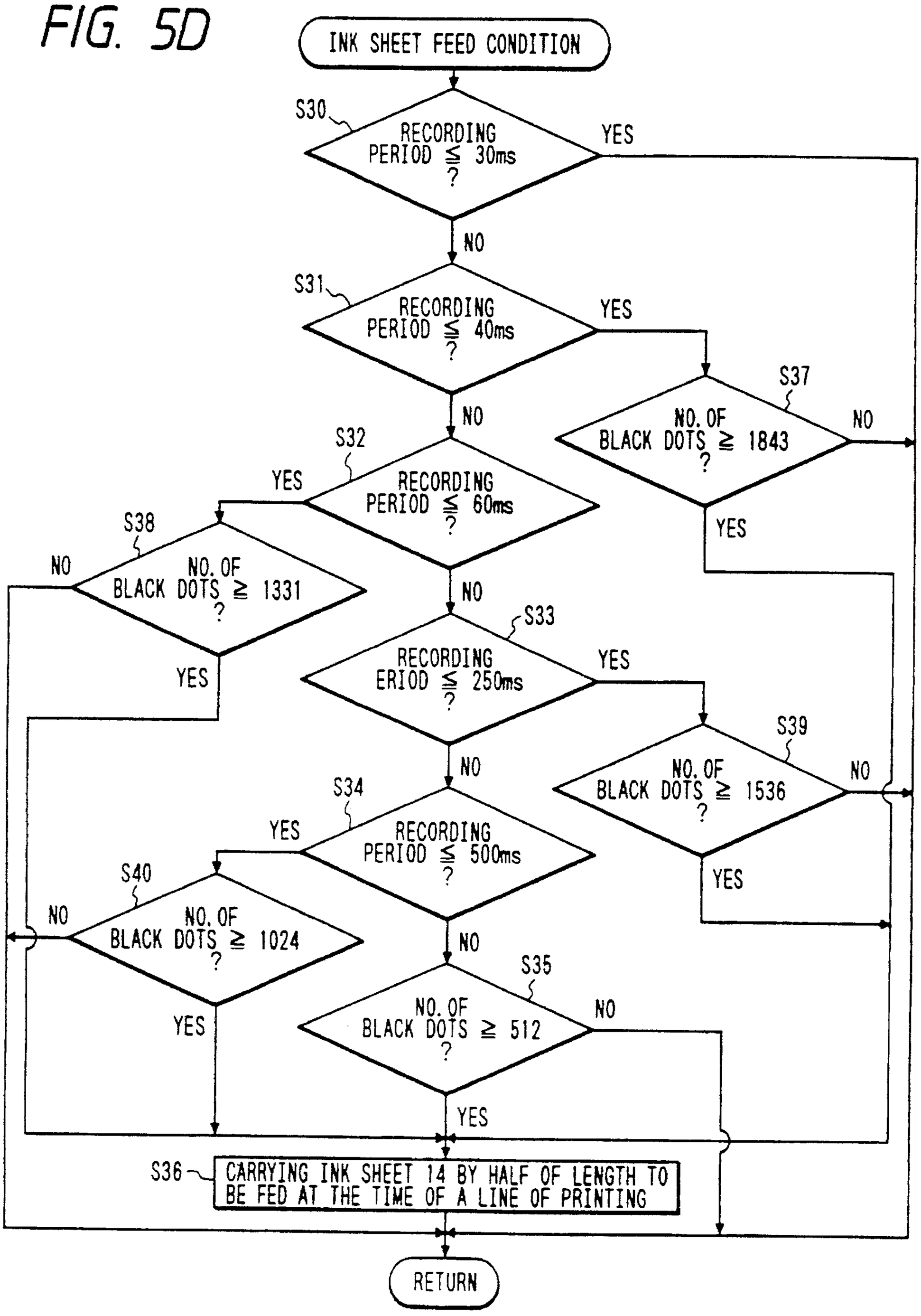

INK SHEET FEED CONDITION
S30
RECORDING PERIOD ≦ 30ms ?
YES
NO
S31
RECORDING PERIOD ≦ 40ms ?
YES
NO
S32
RECORDING PERIOD ≦ 60ms ?
YES
NO
S33
RECORDING ERIOD ≦ 250ms ?
YES
NO
S34
RECORDING PERIOD ≦ 500ms ?
YES
NO
S35
NO. OF BLACK DOTS ≧ 512 ?
NO
YES
S36
CARRYING INK SHEET 14 BY HALF OF LENGTH TO BE FED AT THE TIME OF A LINE OF PRINTING
S37
NO. OF BLACK DOTS ≧ 1843 ?
NO
YES
S38
NO. OF BLACK DOTS ≧ 1331 ?
NO
YES
S39
NO. OF BLACK DOTS ≧ 1536 ?
NO
YES
S40
NO. OF BLACK DOTS ≧ 1024 ?
NO
YES
RETURN

FIG. 6

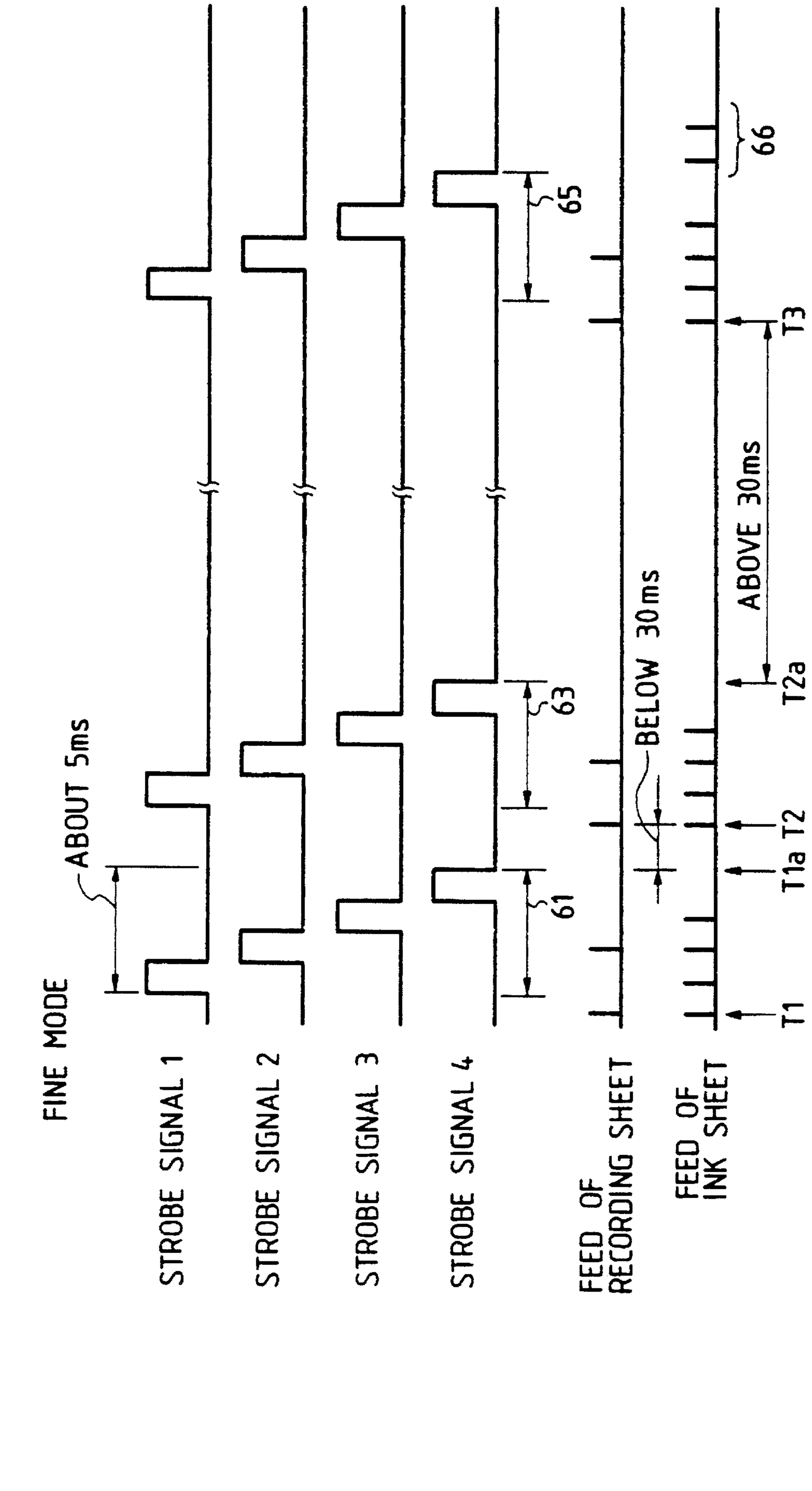

FINE MODE
ABOUT 5ms
STROBE SIGNAL 1
STROBE SIGNAL 2
STROBE SIGNAL 3
STROBE SIGNAL 4
FEED OF RECORDING SHEET
FEED OF INK SHEET
61
63
65
66
BELOW 30ms
ABOVE 30ms
T1
T1a T2
T2a
T3

FIG. 7

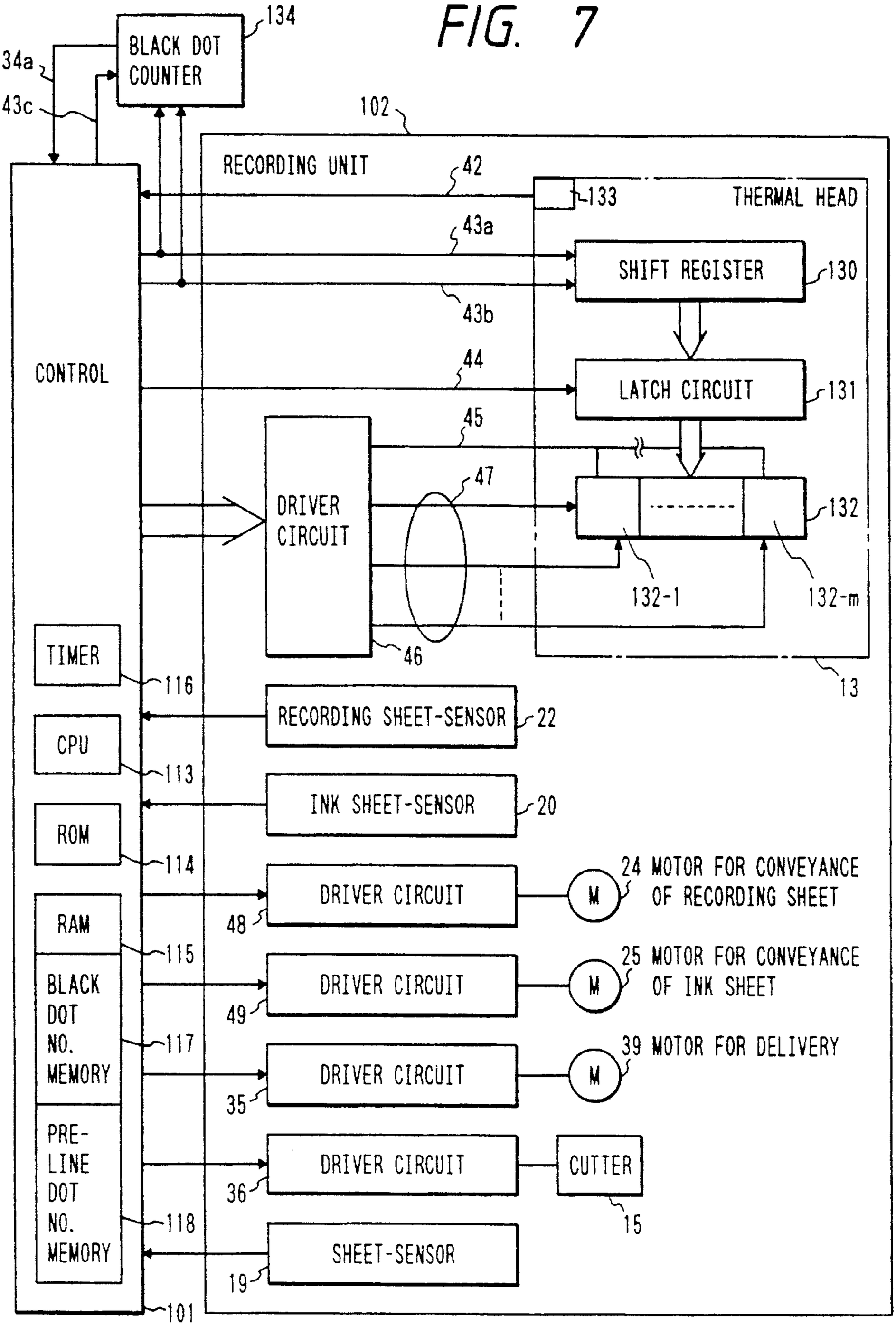

134
BLACK DOT COUNTER
134a
43c
102
RECORDING UNIT
42
133
THERMAL HEAD
43a
SHIFT REGISTER
130
43b
CONTROL
44
LATCH CIRCUIT
131
45
47
DRIVER CIRCUIT
132
132-1
132-m
TIMER
116
46
13
RECORDING SHEET-SENSOR
22
CPU
113
INK SHEET-SENSOR
20
ROM
114
DRIVER CIRCUIT
24 MOTOR FOR CONVEYANCE OF RECORDING SHEET
M
48
RAM
115
DRIVER CIRCUIT
25 MOTOR FOR CONVEYANCE OF INK SHEET
M
BLACK DOT NO. MEMORY
117
49
39 MOTOR FOR DELIVERY
DRIVER CIRCUIT
M
35
PRE-LINE DOT NO. MEMORY
DRIVER CIRCUIT
CUTTER
36
118
15
SHEET-SENSOR
19
101

FIG. 8A-1

FIG. 8A

FIG. 8A-1
FIG. 8A-2

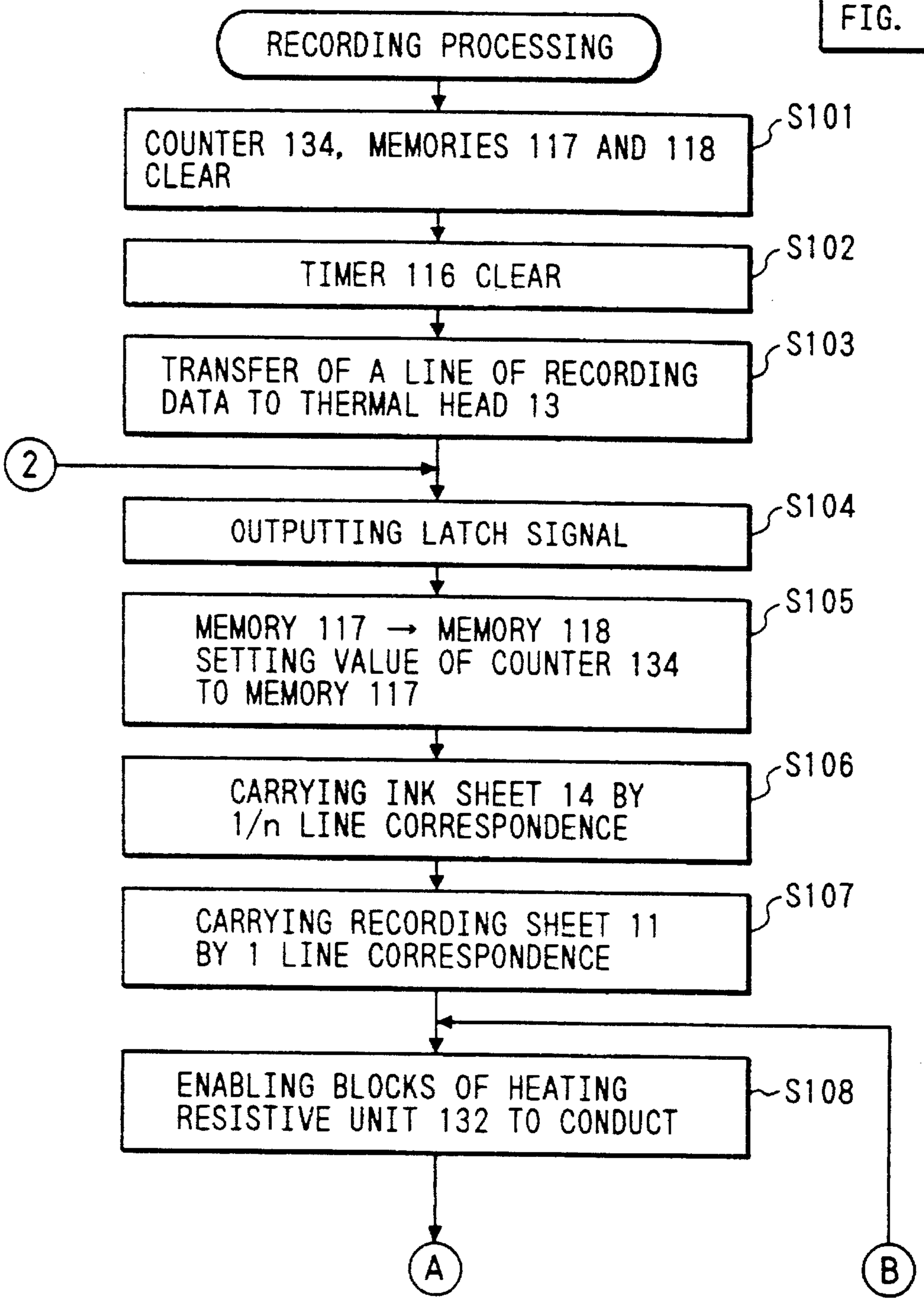


FIG. 8A-2

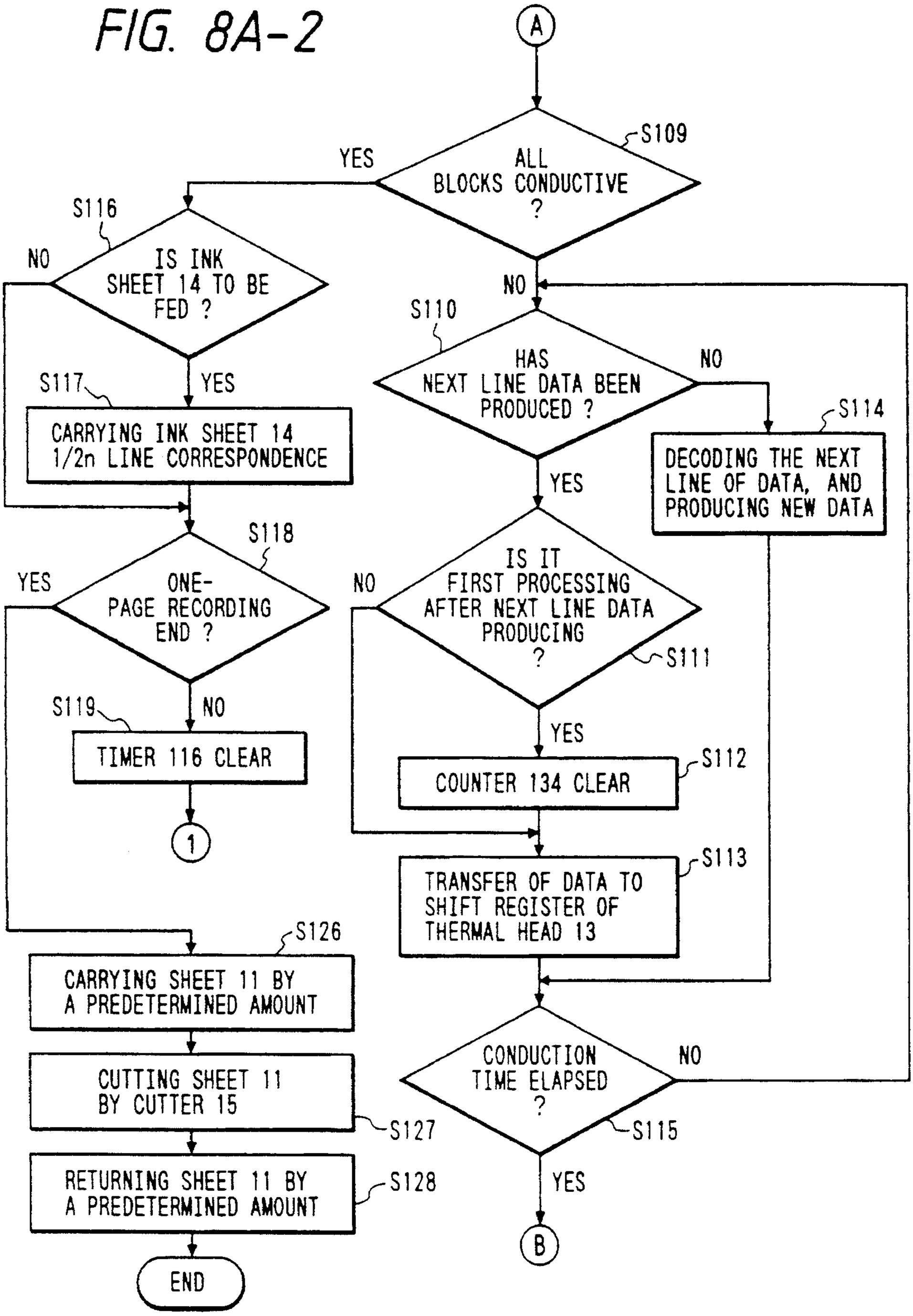

A
S109
ALL BLOCKS CONDUCTIVE ?
YES
NO
S116
IS INK SHEET 14 TO BE FED ?
NO
YES
S117
CARRYING INK SHEET 14 1/2n LINE CORRESPONDENCE
S110
HAS NEXT LINE DATA BEEN PRODUCED ?
NO
YES
S114
DECODING THE NEXT LINE OF DATA, AND PRODUCING NEW DATA
S118
ONE-PAGE RECORDING END ?
YES
NO
S119
TIMER 116 CLEAR
1
IS IT FIRST PROCESSING AFTER NEXT LINE DATA PRODUCING ?
NO
YES
S111
S112
COUNTER 134 CLEAR
S113
TRANSFER OF DATA TO SHIFT REGISTER OF THERMAL HEAD 13
S126
CARRYING SHEET 11 BY A PREDETERMINED AMOUNT
CUTTING SHEET 11 BY CUTTER 15
S127
RETURNING SHEET 11 BY A PREDETERMINED AMOUNT
S128
END
CONDUCTION TIME ELAPSED ?
NO
YES
S115
B

FIG. 8B

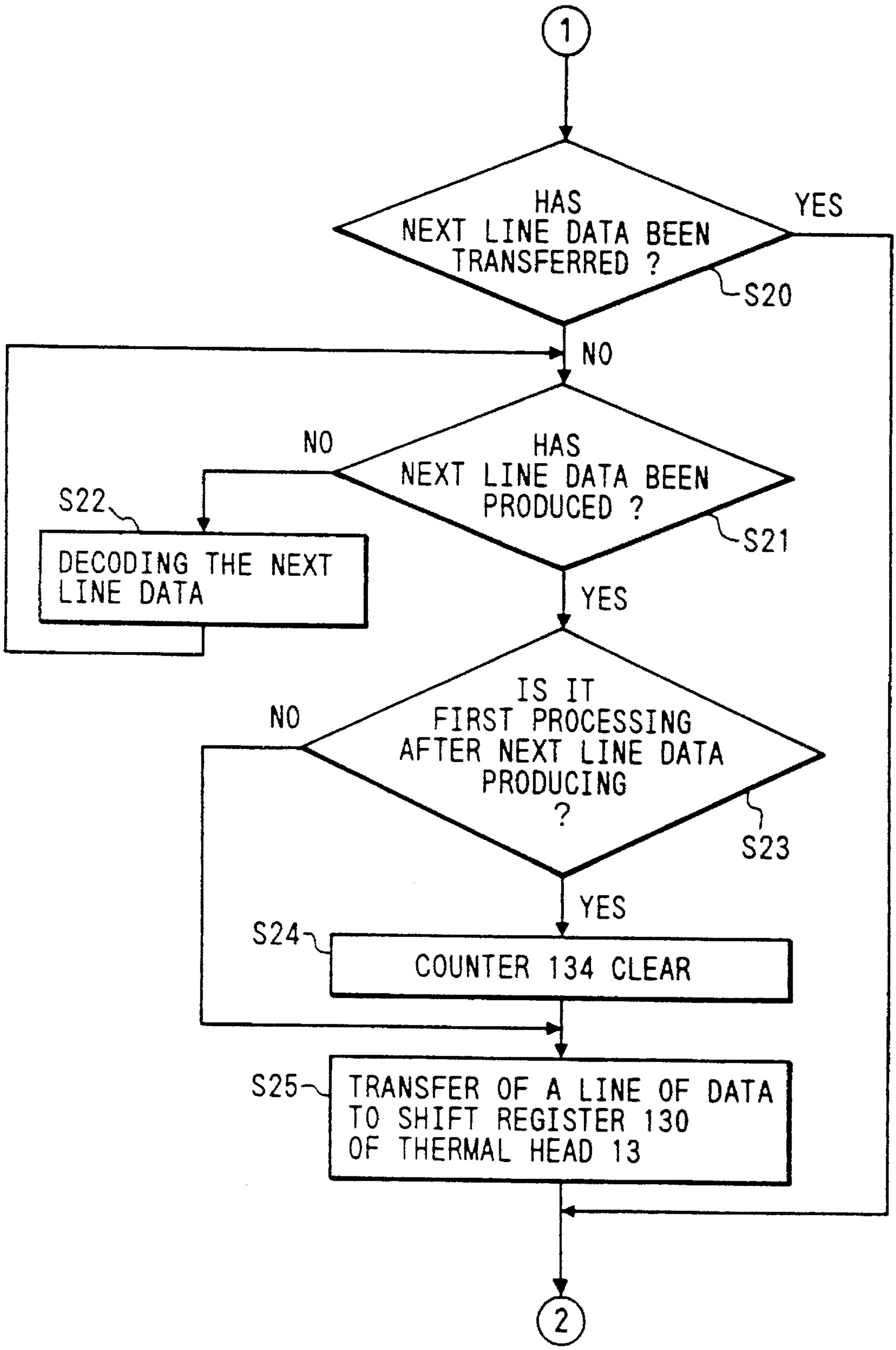

1
HAS NEXT LINE DATA BEEN TRANSFERRED ?
YES
S20
NO
HAS NEXT LINE DATA BEEN PRODUCED ?
NO
S21
S22
DECODING THE NEXT LINE DATA
YES
IS IT FIRST PROCESSING AFTER NEXT LINE DATA PRODUCING ?
NO
S23
YES
S24
COUNTER 134 CLEAR
S25
TRANSFER OF A LINE OF DATA TO SHIFT REGISTER 130 OF THERMAL HEAD 13
2

FIG. 8D

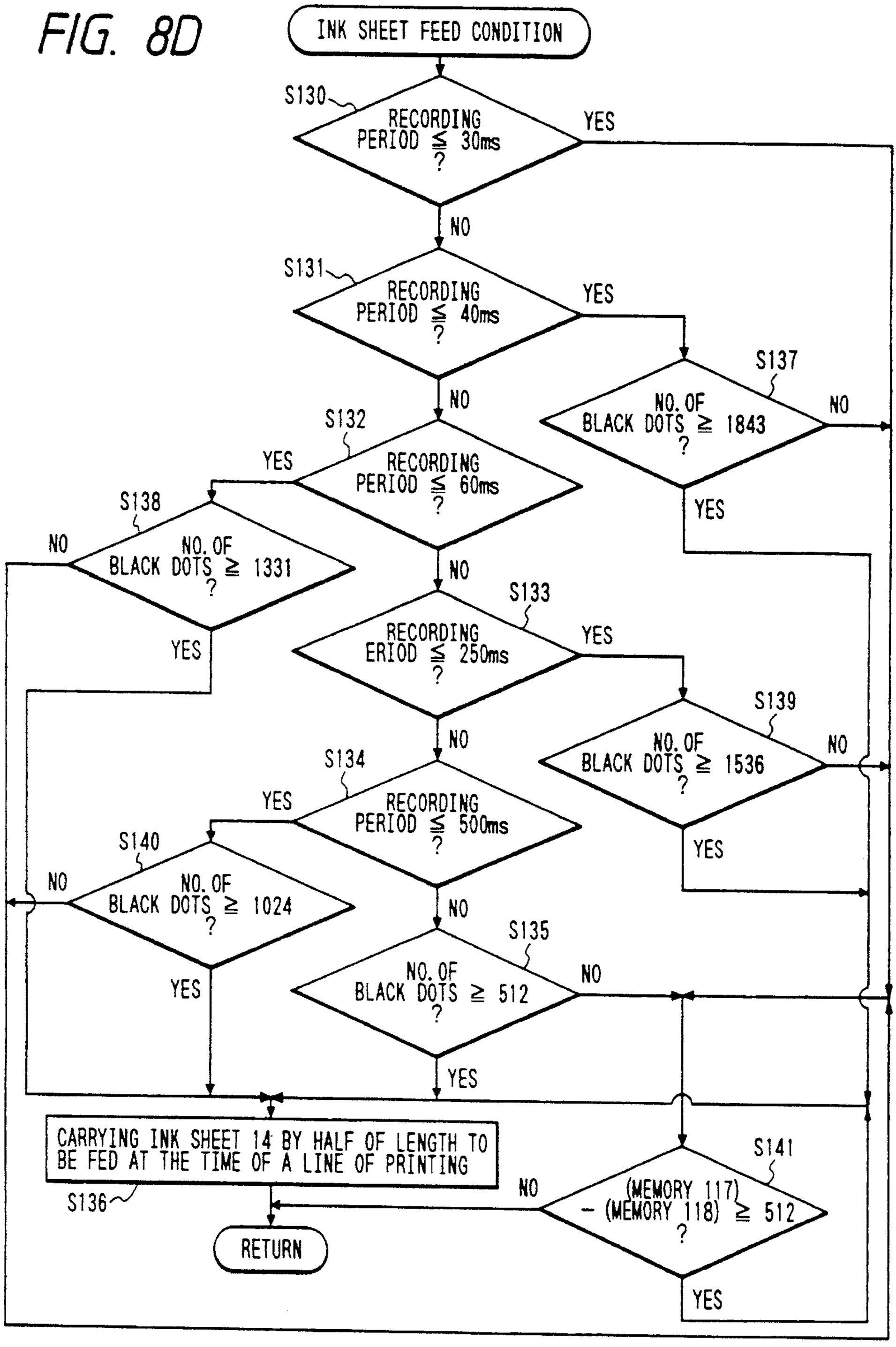

INK SHEET FEED CONDITION
S130
RECORDING PERIOD ≦ 30ms ?
YES
NO
S131
RECORDING PERIOD ≦ 40ms ?
YES
NO
S137
NO. OF BLACK DOTS ≧ 1843 ?
NO
YES
S132
RECORDING PERIOD ≦ 60ms ?
YES
NO
S138
NO. OF BLACK DOTS ≧ 1331 ?
NO
YES
S133
RECORDING ERIOD ≦ 250ms ?
YES
NO
S139
NO. OF BLACK DOTS ≧ 1536 ?
NO
YES
S134
RECORDING PERIOD ≦ 500ms ?
YES
NO
S140
NO. OF BLACK DOTS ≧ 1024 ?
NO
YES
S135
NO. OF BLACK DOTS ≧ 512 ?
NO
YES
CARRYING INK SHEET 14 BY HALF OF LENGTH TO BE FED AT THE TIME OF A LINE OF PRINTING
S136
RETURN
S141
(MEMORY 117) − (MEMORY 118) ≧ 512 ?
NO
YES

FIG. 9

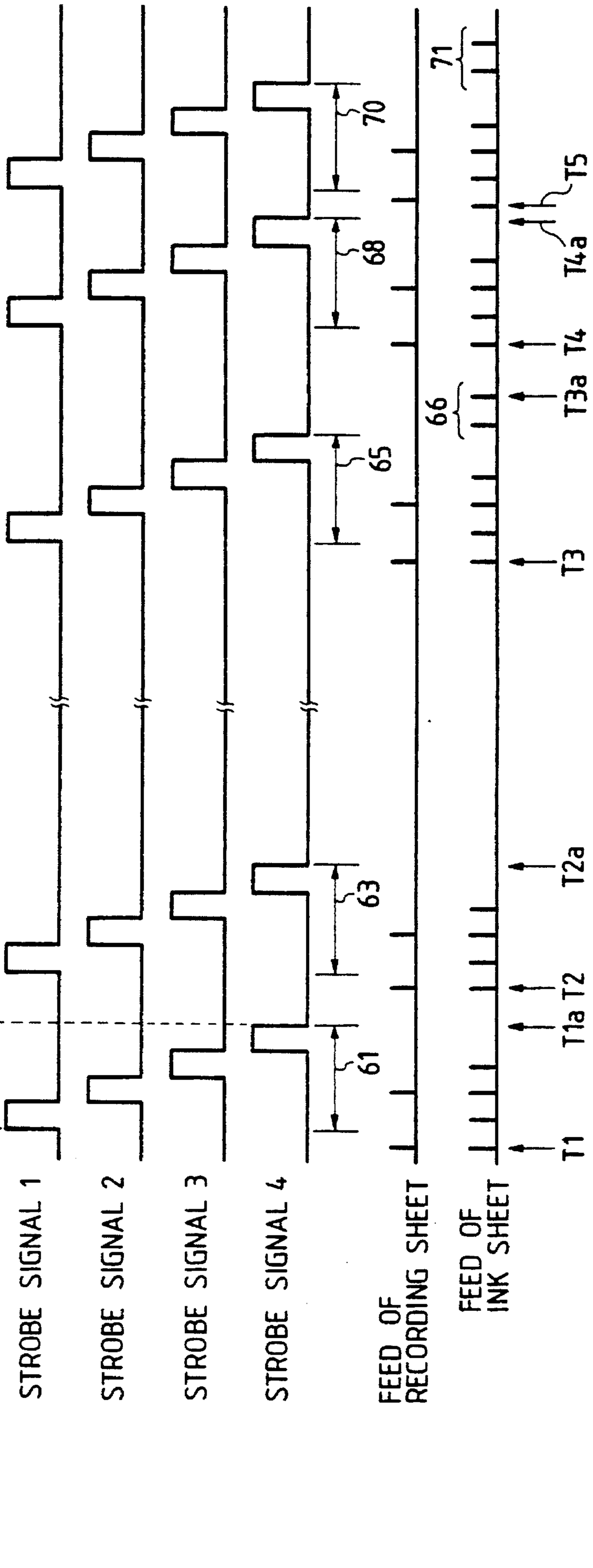

FINE MODE
5ms
STROBE SIGNAL 1
STROBE SIGNAL 2
STROBE SIGNAL 3
STROBE SIGNAL 4
FEED OF RECORDING SHEET
FEED OF INK SHEET
61
63
65
66
68
70
71
T1
T1a
T2
T2a
T3
T3a
T4
T4a
T5

FIG. 10

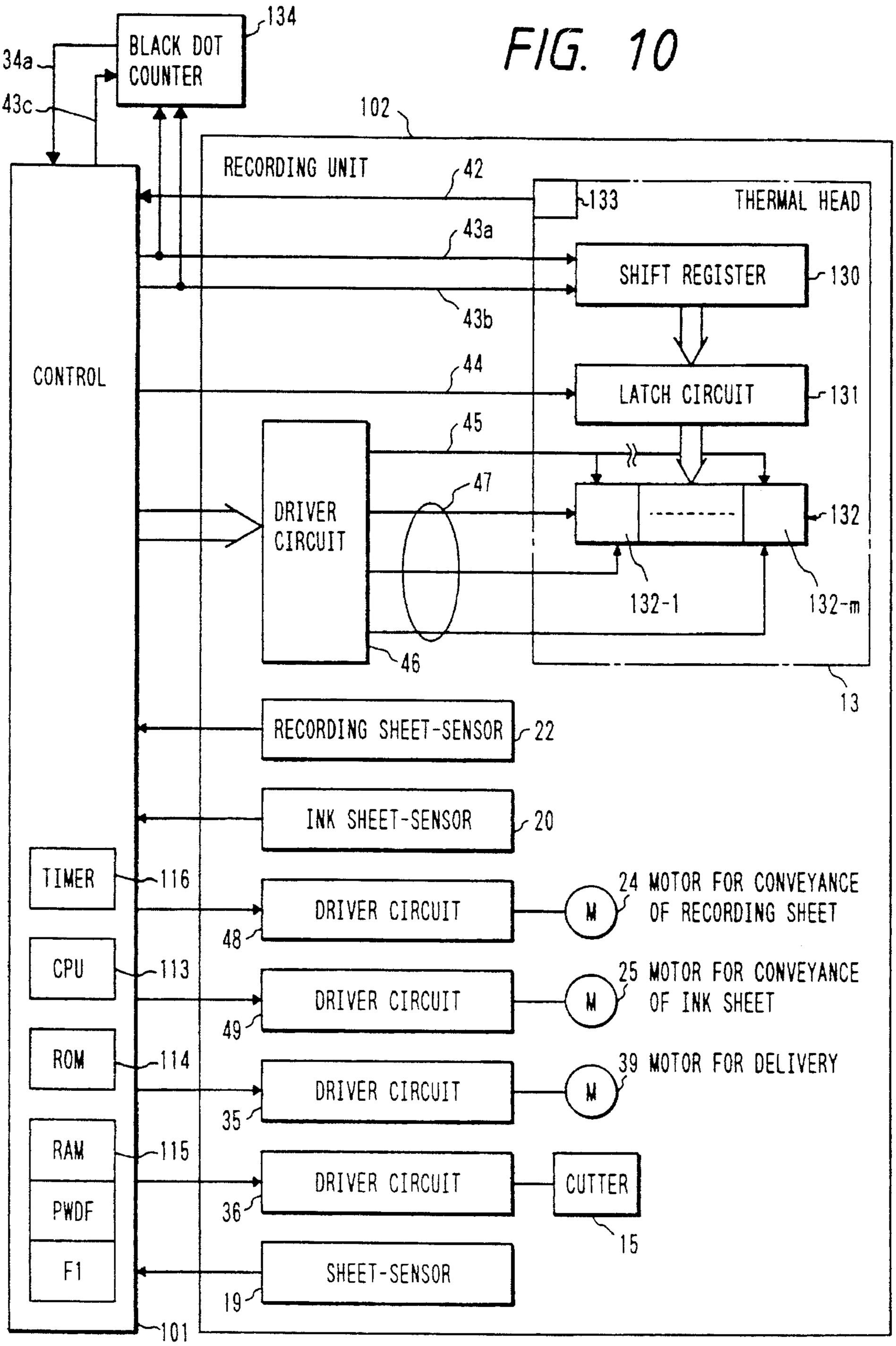

134
BLACK DOT COUNTER
134a
43c
102
RECORDING UNIT
42
133
THERMAL HEAD
43a
SHIFT REGISTER
130
43b
CONTROL
44
LATCH CIRCUIT
131
45
DRIVER CIRCUIT
47
132
132-1
132-m
46
13
RECORDING SHEET-SENSOR
22
INK SHEET-SENSOR
20
TIMER
116
DRIVER CIRCUIT
24 MOTOR FOR CONVEYANCE OF RECORDING SHEET
M
48
CPU
113
DRIVER CIRCUIT
25 MOTOR FOR CONVEYANCE OF INK SHEET
M
49
ROM
114
DRIVER CIRCUIT
39 MOTOR FOR DELIVERY
M
35
RAM
115
DRIVER CIRCUIT
CUTTER
PWDF
36
15
F1
SHEET-SENSOR
19
101

FIG. 11A

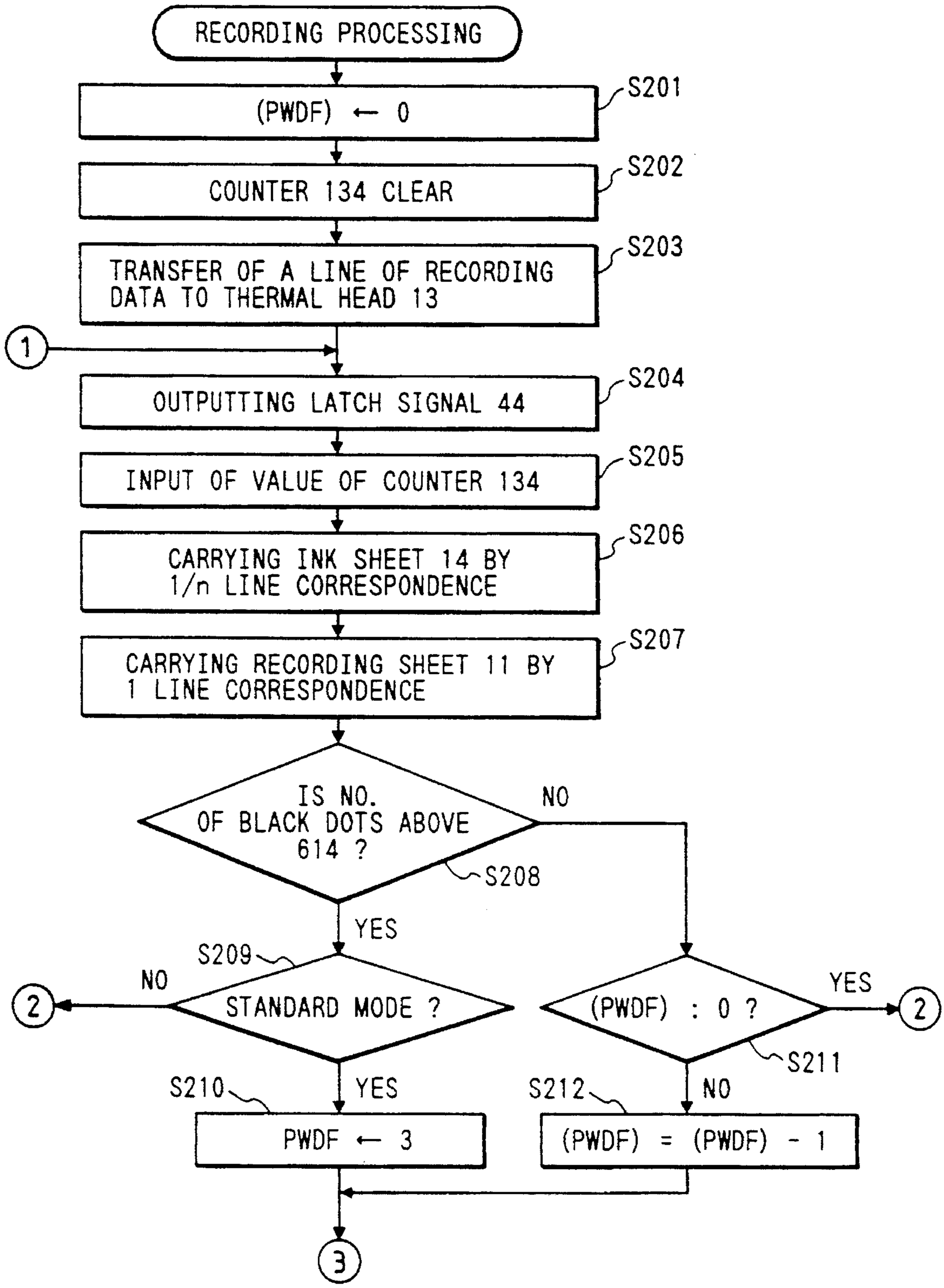

RECORDING PROCESSING
(PWDF) ← 0
S201
COUNTER 134 CLEAR
S202
TRANSFER OF A LINE OF RECORDING DATA TO THERMAL HEAD 13
S203
1
OUTPUTTING LATCH SIGNAL 44
S204
INPUT OF VALUE OF COUNTER 134
S205
CARRYING INK SHEET 14 BY 1/n LINE CORRESPONDENCE
S206
CARRYING RECORDING SHEET 11 BY 1 LINE CORRESPONDENCE
S207
IS NO. OF BLACK DOTS ABOVE 614 ?
S208
NO
YES
S209
NO
STANDARD MODE ?
2
YES
(PWDF) : 0 ?
S211
2
S210
YES
PWDF ← 3
S212
NO
(PWDF) = (PWDF) - 1
3

FIG. 11B

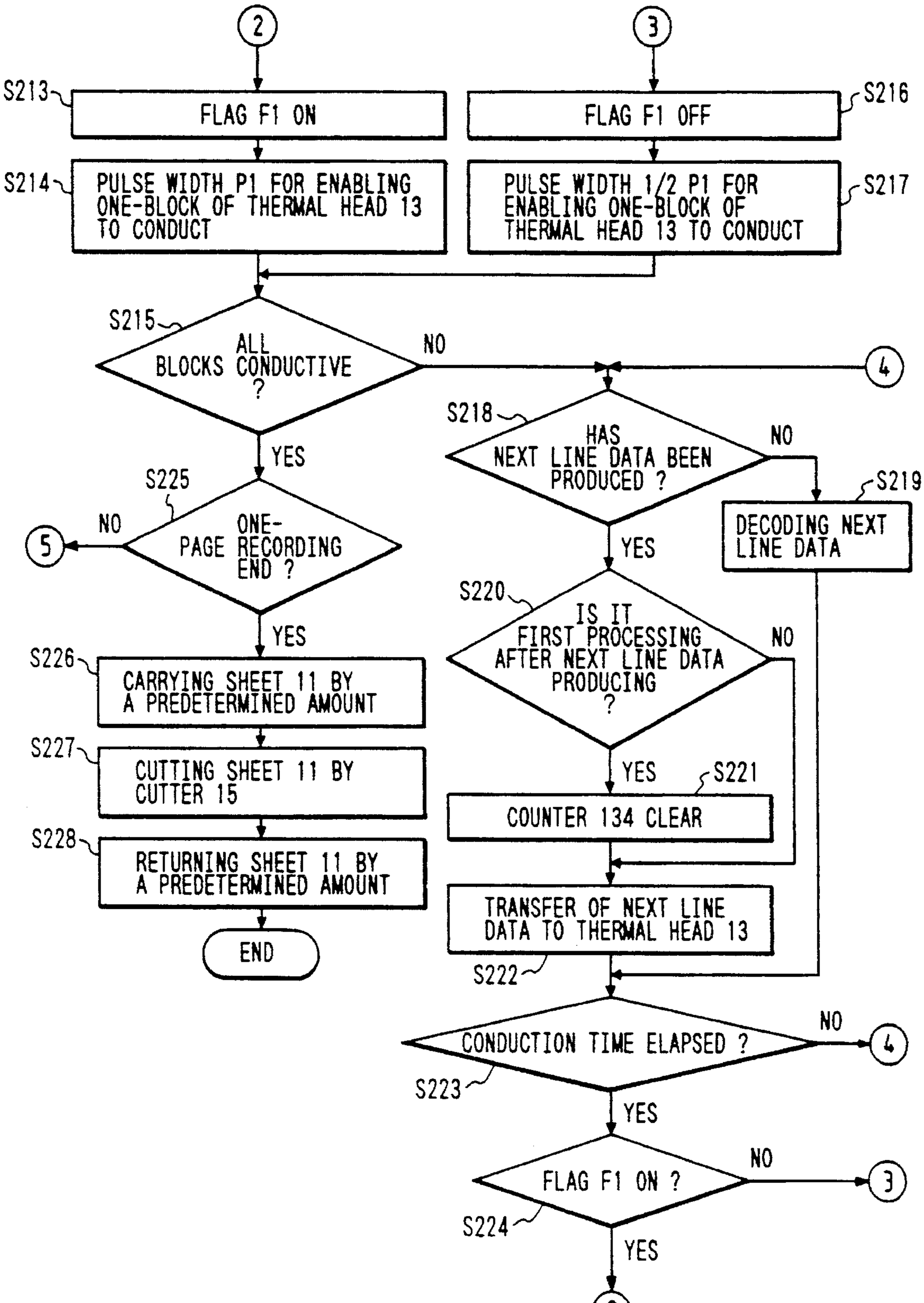

2
3
S213
FLAG F1 ON
S216
FLAG F1 OFF
S214
PULSE WIDTH P1 FOR ENABLING ONE-BLOCK OF THERMAL HEAD 13 TO CONDUCT
S217
PULSE WIDTH 1/2 P1 FOR ENABLING ONE-BLOCK OF THERMAL HEAD 13 TO CONDUCT
S215
ALL BLOCKS CONDUCTIVE ?
NO
4
YES
S218
HAS NEXT LINE DATA BEEN PRODUCED ?
NO
S219
DECODING NEXT LINE DATA
S225
ONE-PAGE RECORDING END ?
NO
5
YES
S220
IS IT FIRST PROCESSING AFTER NEXT LINE DATA PRODUCING ?
NO
YES
S221
COUNTER 134 CLEAR
S226
CARRYING SHEET 11 BY A PREDETERMINED AMOUNT
S227
CUTTING SHEET 11 BY CUTTER 15
S228
RETURNING SHEET 11 BY A PREDETERMINED AMOUNT
END
TRANSFER OF NEXT LINE DATA TO THERMAL HEAD 13
S222
CONDUCTION TIME ELAPSED ?
NO
4
S223
YES
FLAG F1 ON ?
NO
3
S224
YES
2

FIG. 11C

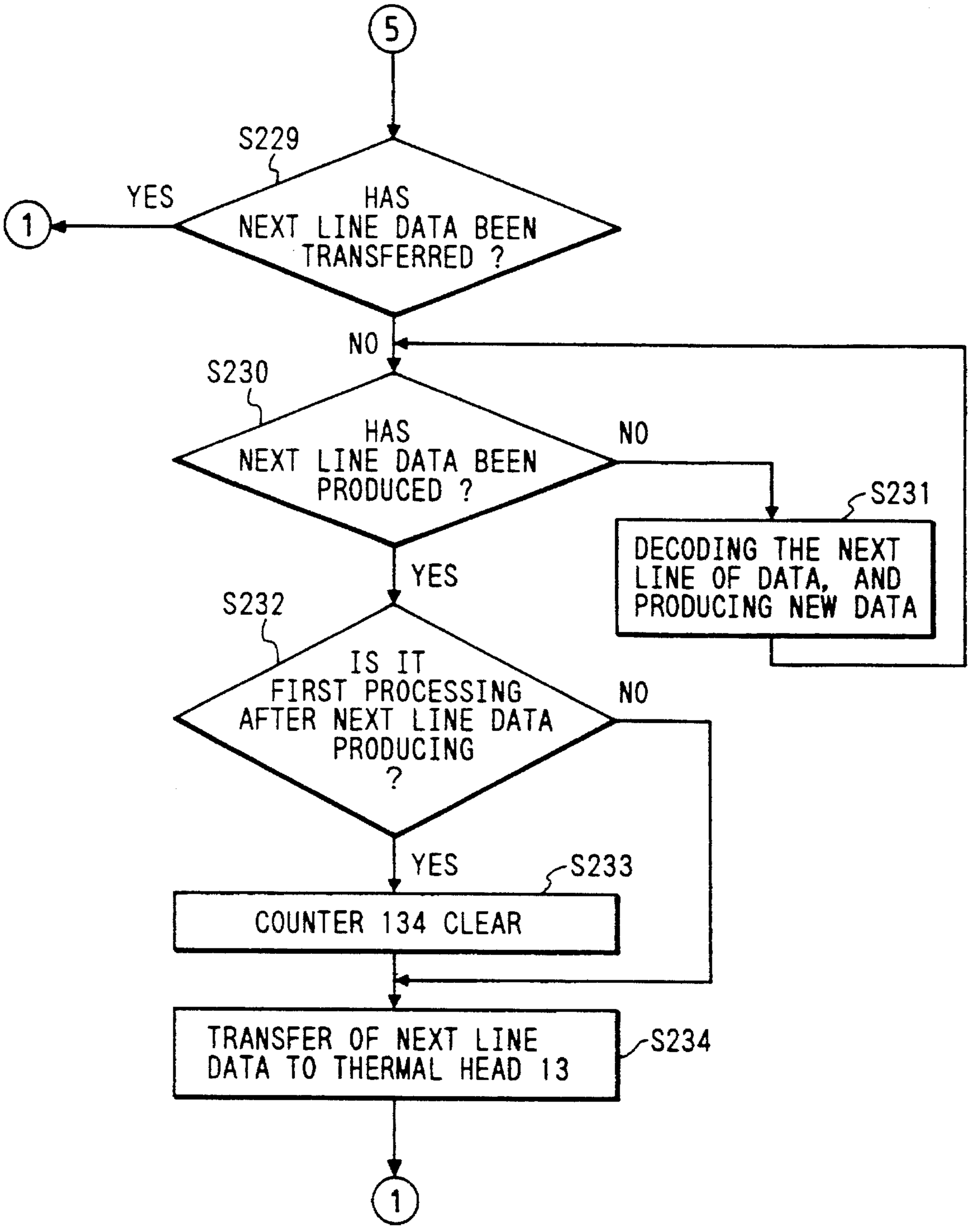

5
S229
YES
HAS NEXT LINE DATA BEEN TRANSFERRED ?
1
NO
S230
HAS NEXT LINE DATA BEEN PRODUCED ?
NO
S231
DECODING THE NEXT LINE OF DATA, AND PRODUCING NEW DATA
YES
S232
IS IT FIRST PROCESSING AFTER NEXT LINE DATA PRODUCING ?
NO
YES
S233
COUNTER 134 CLEAR
TRANSFER OF NEXT LINE DATA TO THERMAL HEAD 13
S234
1

FIG. 12

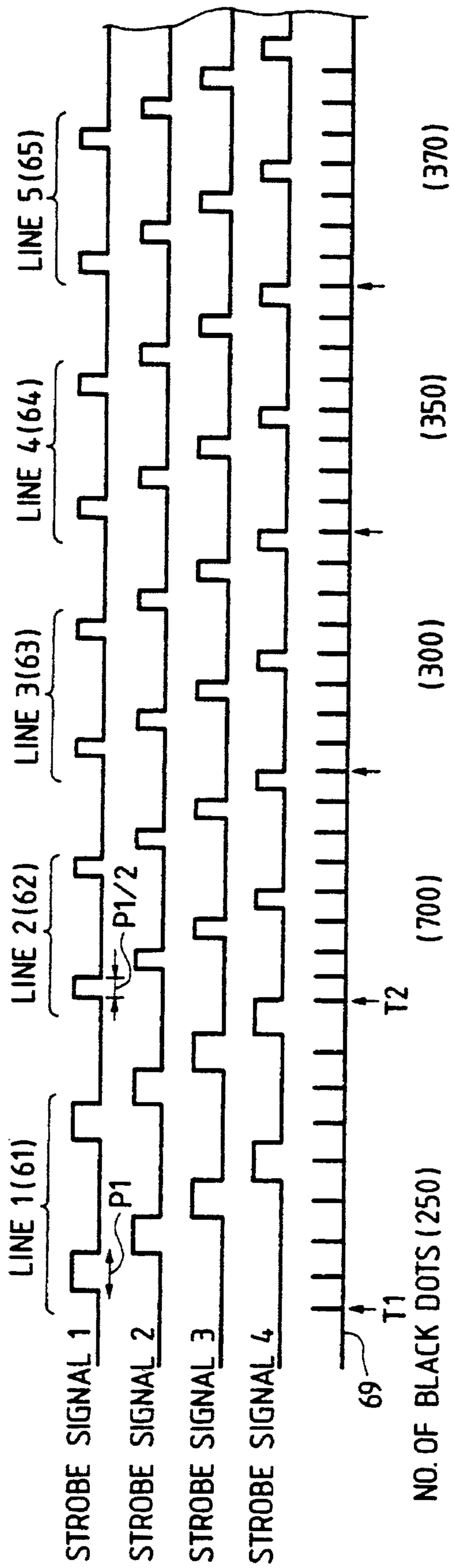

LINE 1(61)
LINE 2(62)
LINE 3(63)
LINE 4(64)
LINE 5(65)
LINE 6(66)
P1
P1/2
T1
T2
(300)
(350)
(370)
(700)
STROBE SIGNAL 1
STROBE SIGNAL 2
STROBE SIGNAL 3
STROBE SIGNAL 4
69
NO. OF BLACK DOTS (250)
(370) NO. OF BLACK DOTS

FIG. 13

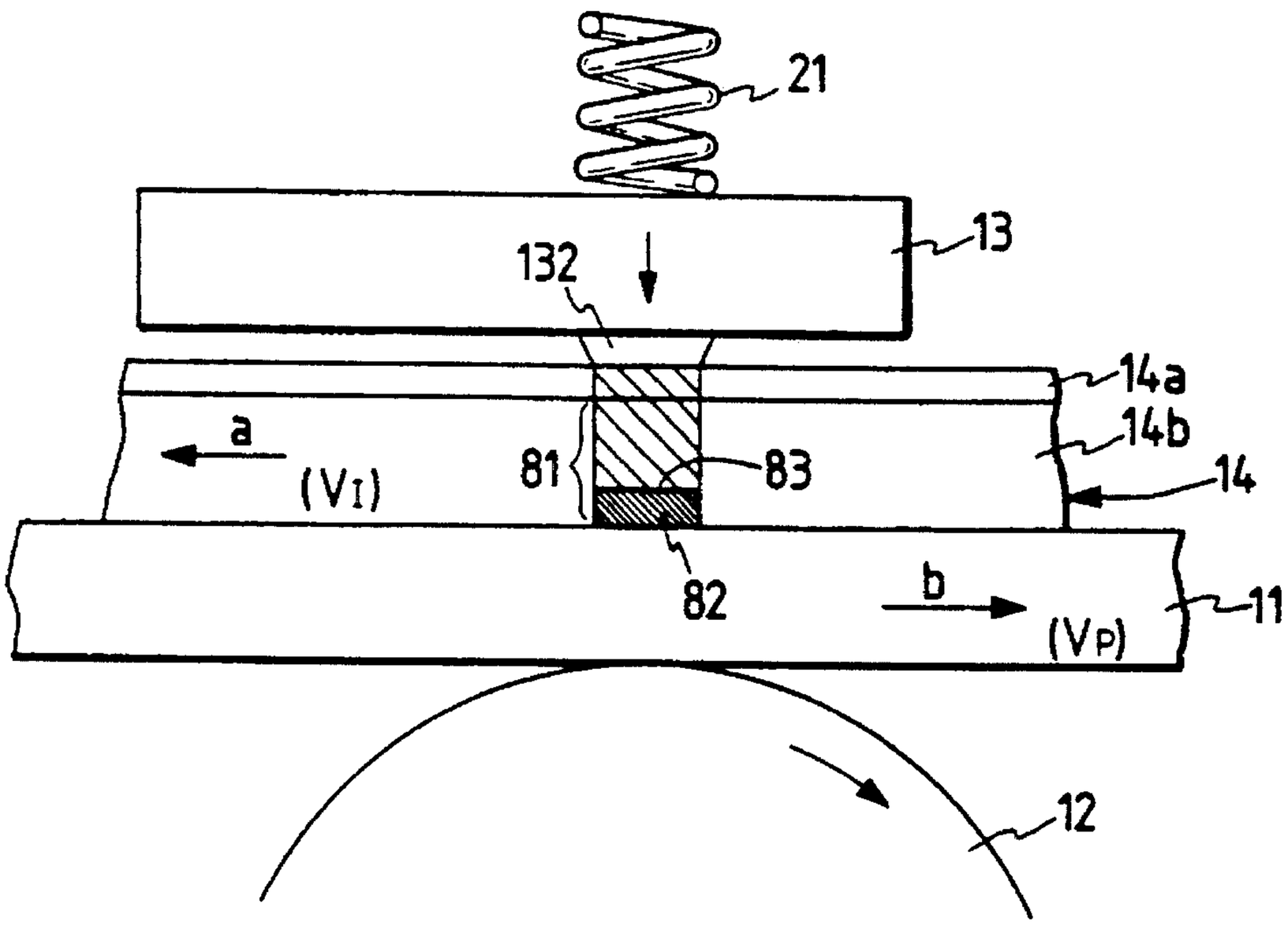
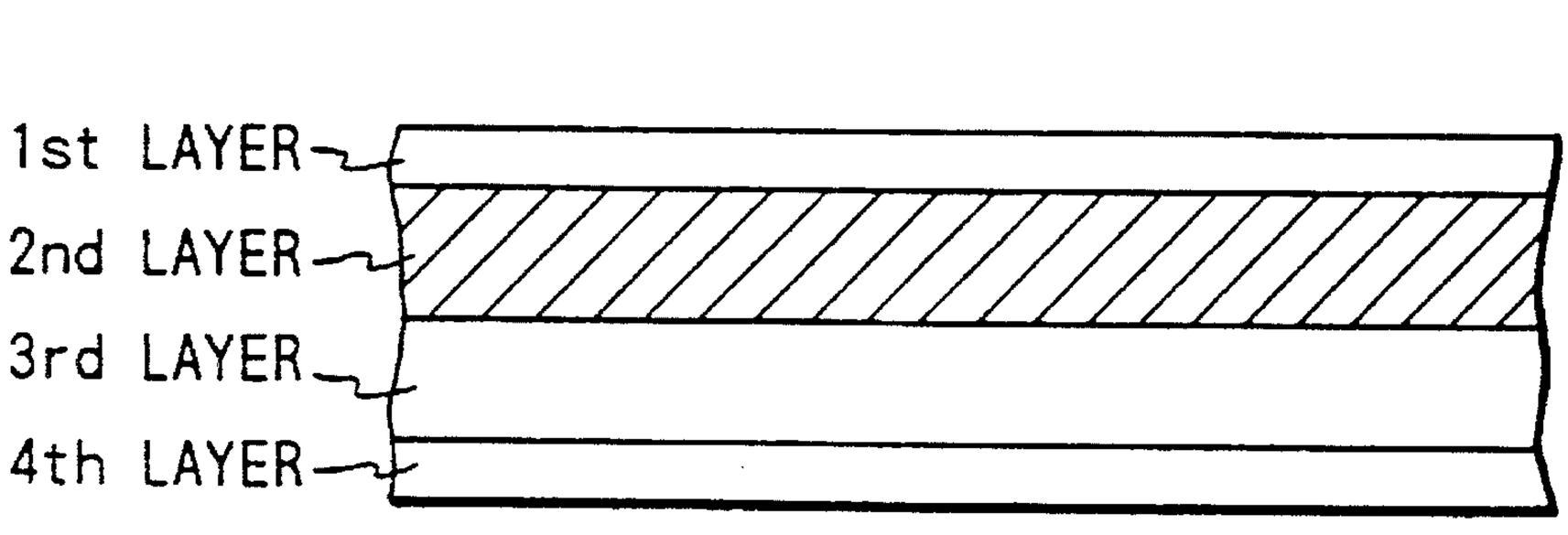

21
13
132
14a
14b
14
a
(VI)
81
83
82
b
(VP)
11
12

FIG. 14


14
1st LAYER
2nd LAYER
3rd LAYER
4th LAYER

RECORDING APPARATUS WITH CONTROLLED THERMAL TRANSFER ENERGY

This application is a division of application Ser. No. 07/775,122 filed Oct. 11, 1991.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a thermal transfer recording apparatus for recording image on a recording medium by transferring ink contained in an ink sheet to the recording medium, and a facsimile apparatus using the aforesaid apparatus.

2. Related Background Art

In general, a thermal transfer printer uses an ink sheet with a thermally fusible (or thermally sublimate) ink coated on the base film thereof, and selectively heats such ink sheet by the thermal head in response to image signals in order to transfer the fused (or sublimated) ink to a recording sheet for image recording. Usually, an ink sheet of the kind is such that the contained ink is completely transferred to the recording sheet for one image recording (the so-called one-time sheet). Therefore, it is necessary to convey the ink sheet for an amount equivalent to the length of recorded one character or one line of image after the image recording has been completed, so that the unused portion of the ink sheet should reliably be brought forward to the position for the next recording. Thus the consumption of the ink sheet becomes great and the running cost of the thermal transfer printer tends to be higher than that of a usual thermal printer using thermal sheets for recording.

With a view to solving a problem such as this, there has been proposed a thermal transfer printer in which a recording sheet and an ink sheet are conveyed with a difference in the conveying speeds thereof such as disclosed in Japanese Patent Laid-Open Patent Application No. 57-83471, Japanese Patent Laid-Open Application No. 58-201686 or Japanese Patent Publication No. 62-58917.

The present invention is designed to make a further development of those patents disclosed in the aforesaid applications or publication.

As the ink sheet to be used for these thermal transfer printers, there is known an ink sheet (multiprint sheet) capable of recording images for plural times (n). Then, when a length L of recording is continuously performed using this ink sheet, it is possible to carry on such a recording by making the length of the ink sheet conveyed after each image recording has been completed or during the image being recorded shorter than the length L by (L/n: n>1). Hence, the ink sheet usability efficiency becomes more than the conventional case by n times, and a reduction of the running cost of the thermal transfer printer can be expected. Hereinafter, this recording method is referred to as multiprint.

In the case of a multiprint such as this, the ink layer of the ink sheet is heated by n times separately. Then, at each time of heating, the ink transfer to the recording sheet is performed by generating a shearing force between the fused ink on the ink layer and the ink yet to be fused thereon. As a result, if, for example, the temperature of ink is lowered due to a longer period of time having elapsed before the recording of the next line subsequent to the recording of one line, the force required to shear between the fused ink and the ink yet to be fused (sublimated) becomes greater, leading to a problem that the ink sheet and recording sheet are not easily separable. This condition is particularly conspicuous when a one line recording data contains more black information, and in a facsimile apparatus or the like in which a time interval between a current line and the next line is not constant and such time interval tends to be comparatively long, this condition presents a problem.

In other words, when black information is contained in a considerable amount, the force required to shear between ink layers becomes great if the recording cycle is long because the ink which has once been fused is cooled and this phenomenon appears as an adhesion of the ink sheet to the recording sheet. Therefore, there is a possibility that if a predetermined number of lines should be recorded subsequent to having recorded a line information containing higher black dot numbers, an adhesion such as this occurs depending on its recording cycle and black data rate in one line. If such adhesive force is increased, an elongation of the ink sheet, deflection of the rubber of the platen roller, and the like are generated, making the velocities of the ink sheet and recording sheet essentially equal. Hence, the relative velocities thereof are brought into a level close to substantially zero and there is a possibility that the recording quality is lowered due to the multiprint thus applied.

SUMMARY OF THE INVENTION

The present invention is designed in consideration of the above-mentioned problems, and the object thereof is to provide an improved thermal transfer recording apparatus, and a facsimile apparatus using the aforesaid apparatus.

Another object of the present invention is to provide a thermal transfer recording apparatus capable of preventing any degradation of the recording quality at the time of the multiprint performance and, a facsimile apparatus using the aforesaid apparatus.

Still another object of the present invention is to provide a thermal recording apparatus making it possible to separate with ease the ink sheet and recording sheet subsequent to the image recording, and a facsimile apparatus using the aforesaid apparatus.

A further object of the present invention is to provide a thermal transfer recording apparatus capable of preventing the adhesion of the ink sheet by controlling the ink sheet conveyance or the energy supply to the recording head on the basis of the black dot numbers included in a recording information and recording interval, and a facsimile apparatus using the aforesaid apparatus.

Still a further object of the present invention is to provide a thermal transfer recording apparatus performing its operation in such a manner that the black dot numbers thereby to have recorded an image on a recording medium by energizing the ink sheet are counted and at the same time, the elapsed time after the recording of the last line is measured, and that in response to such measurement of the elapsed time and the counting value obtained by the counting means, the ink sheet is conveyed for a predetermined length without conveying the recording sheet subsequent to the image having been recorded, and a facsimile apparatus using the aforesaid apparatus.

Still a further object of the present invention is to provide a thermal transfer recording apparatus performing its operation in such a manner that the recorded black dot numbers are counted and at the same time, the elapsed time after the recording of the last line is measured, and on the basis of the elapsed time measured by the timer means and the counting

value obtained by the counting means or of the difference between the black dot numbers recorded in the last line and the current line, the ink sheet is conveyed for a predetermined length without conveying the recording sheet subsequent to the image having been recorded, and a facsimile apparatus using the aforesaid apparatus.

Still a further object of the present invention is to provide a thermal transfer recording apparatus making it possible to control the energy supply to the recording head in response to the black dot numbers contained in a recording information and the recording mode, and a facsimile apparatus using the aforesaid apparatus.

The above-mentioned and other objects, features and advantages of the present invention will become clear by reference to the following detailed description of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram showing the electrical connection of the control unit and recording unit of a facsimile apparatus according to a first embodiment of the present invention;

FIG. **2** is a block diagram showing the schematic structure of a facsimile apparatus according to the present embodiment.

FIG. **3** is a cross-sectional side view showing the mechanical section of a facsimile apparatus according to the present embodiment,

FIG. **4** is a perspective view showing the mechanism to convey the recording sheet and ink sheet according to the present embodiment.

FIG. **5**A is a block diagram showing that FIG. **5**A-**1** and FIG. **5**A-**2** are to be read as connected flowcharts.

FIG. **5**A-**1**, FIG. **5**A-**2** and FIG. **5**B are flowcharts showing the recording processing in the facsimile apparatus according to the first embodiment;

FIG. **5**C is a view illustrating conditions to determine whether or not any excessive conveyance of the ink sheet should be performed after the completion of a one line recording in the facsimile apparatus according to the first embodiment;

FIG. **5**D is a flowchart showing the judgment processing on the basis of the conditions shown in FIG. **5**C;

FIG. **6** is a timing chart showing the timing for energizing the thermal head as well as for conveying the ink sheet and recording sheet in the recording processing in the first embodiment;

FIG. **7** is a block diagram showing the electrical connection between the control unit and recording unit in a facsimile apparatus according to a second embodiment of the present invention;

FIG. **8**A is a block diagram showing that FIG. **8**A-**1** and FIG. **8**A-**2** are to be read as connected flowcharts.

FIG. **8**A-**1**, FIG. **8**A-**2** and FIG. **8**B are flowcharts showing the recording processing in the facsimile apparatus according to the second embodiment;

FIG. **8**C is a view illustrating conditions to determine whether or not any excessive conveyance of the ink sheet should be performed after the completion of a one line recording in the facsimile apparatus according to the second embodiment;

FIG. **8**D is a flowchart showing the judgment processing on the basis of the conditions shown in FIG. **8**C;

FIG. **9** is a timing chart showing the timing for energizing the thermal head as well as for conveying the ink sheet and recording sheet in the recording processing the second embodiment;

FIG. **10** is a block diagram showing the electrical connection between the control unit and recording unit in a facsimile apparatus according to a third embodiment of the present invention;

FIG. **11**A, FIG. **11**B and FIG. **11**C are flowcharts showing the recording processing in the facsimile apparatus according to the third embodiment;

FIG. **12** is a timing chart showing the timing for energizing the thermal head as well as for conveying the ink sheet and recording sheet in the recording processing in the third embodiment;

FIG. **13** is a view illustrating the principle of the multi-print at the time of recording in the first through third embodiments; and

FIG. **14** is a view showing the sectional shape of the multi-ink sheet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the embodiments suited for the present invention will be described in detail in reference to the accompanying drawings.

<The Description of A Facsimile Apparatus (FIG. **1** through FIG. **4**)>

FIG. **1**–FIG. **4** are views showing an example of a facsimile apparatus to which a thermal transfer printer using an embodiment of the present invention is applied. FIG. **1** illustrates the electrical connection between the control unit **101** and recording unit **102** of the facsimile apparatus. FIG. **2** is a block diagram showing schematically the structure of the facsimile apparatus. FIG. **3** is a cross-sectional side view of the facsimile apparatus, and FIG. **4** is a view showing the mechanism for conveying the recording sheet and ink sheet.

At first, the schematic structure of a facsimile apparatus according to the present embodiment will be described in conjunction with FIG. **2**.

In FIG. **2**, a reference numeral **100** designates a reading unit comprising a motor for conveying an original, CCD image sensor, and others to read the original photoelectrically and output it into the control unit **101** as digital image signals. Next, the structure of this control unit **101** is described. A reference numeral **110** designates a line memory to store image data from each line of an image data. When the original is transmitted or copied, the image data of one-line portion from the reading unit **100** is stored, and when receiving an image data, a one-line portion of the decoded image data is stored. Then, an image recording is performed by outputting the stored data into the recording unit **102**. A reference numeral **111** designates an encoding/decoding unit to encode an image information to be transmitted by an MH encoding, or the like and at the same time, to decode an encoded image data received and convert it into the image data. Also, a reference numeral **112** designates a buffer memory to store the encoded image data to be transmitted or received. Each of these sections in the control unit **101** is controlled by a CPU **113** comprising a microprocessor and others, for example. In the control unit **101**, there are provided, in addition to this CPU **113**, a ROM **114** for storing the control program for the CPU **113** and various kinds of data and a RAM **115** temporarily storing various kinds of data as the work area for the CPU **113**, and others.

A reference numeral **102** designates a recording unit comprising a thermal line head to perform the recording on a recording sheet using a thermal transfer method. This structure will be described later in detail in reference to FIG. **3**.

A reference numeral **103** designates an operational unit including instruction keys for the transmission start and other functions, keys for inputting telephone numbers, and others; **103***a*, a switch for instructing the kind of ink sheet to be used, indicating that a multiprint ink sheet is in use when the switch **103***a* is on and that an ordinary ink sheet is in use when the switch is off; **104**, a display unit usually installed adjacent to the operational unit **103** to display each state of the functions, systems, and others; **105**, a power supply unit to supply electric power to the entire system; **106**, a MODEM (modulator/demodulator); **107**, a network control unit (NCU) for performing an automatic receiving by detecting a ringing tone as well as line controls; and **108**, a telephone set.

Next, in reference to FIG. **3**, the structure of recording unit **102** is described. In this respect, the unit which is common in each of the figures will be designated by the same number.

In FIG. **3**, a reference numeral **10** designates a rolled sheet which is an ordinary recording sheet **11** wound around a core **10***a*. This rolled sheet **10** is rotatively accommodated in the apparatus so that the recording sheet **11** can be supplied to the thermal head unit **13** by the rotation of a platen roller **12** in the direction indicated by an arrow. In this respect, a reference numeral **10***b* designates a rolled sheet housing in which the rolled sheet **10** can be set detachably. Also, a reference numeral **12** designates a platen roller for conveying the recording sheet **11** in the direction indicated by an arrow b and pressing the ink sheet **14** and recording sheet **11** between the platen roller and the heat resistive unit **132** of thermal head **13** simultaneously. The recording sheet **11** is conveyed by the further rotation of platen roller **12** in the direction towards exhausting rollers **16** (**16***a* and **16***b*) after the image recording has been completed by the heat generation of the thermal head **13**, and is cut into the unit of one page by the engagement of cutters **15** (**15***a* and **15***b*) when the image recording for the one-page portion is completed.

A reference numeral **17** designates an ink sheet supply roller with ink sheet **14** wound around thereon; **18**, an ink sheet winding roller driven by a motor for conveying ink sheet, which will be described later, to take up the ink sheet **14** in the direction indicated by an arrow a. In this respect, these ink sheet supply roller **17** and ink sheet winding roller **18** are detachably accommodated in an ink sheet housing **70** in the main body of the apparatus. Further, a reference numeral **19** designates a sensor for detecting the remaining quantity of ink sheet **14** and the speed at which ink sheet **14** is being conveyed; also, **20**, an ink sheet sensor for detecting the presence of ink sheet **14**; **21**, a spring compressing the thermal head **13** against the platen roller **12** through the recording sheet **11** and ink sheet **14**; and **22**, a recording sheet sensor for detecting the presence of the recording sheet.

Subsequently, the structure of the reading unit **100** will be described.

In FIG. **3**, a reference numeral **30** designates a light source for irradiating the original **32**, and the reflected rays of light from original **32** are inputted into a CCD sensor **31** through an optical system (mirrors **50** and **51**, and a lens **52**), which are converted into electrical signals. The original **32** is conveyed by carrier rollers **53**, **54**, **55**, and **56** driven by a motor (not shown) for conveying original in accordance with a speed at which the original **32** is being read. In this respect, a reference numeral **57** designates an original stacker. The plural sheets of originals **32** stacked on this stacker **57** are separated one by one by the cooperation of the carrier roller **54** and the pressurized separator **58** and conveyed to the reading unit **100**.

A reference numeral **41** designates a control board constituting the major part of control unit **101**. From the control board **41** various control signals are output to each of the units in the apparatus. Also, a reference numeral **105** designates a power supply to supply electric power to each unit; **106**, a MODEM board unit; and **107**, an NCU board unit having functions to relay telephone lines.

Further, FIG. **4** is a perspective view showing the details of mechanism to convey both ink sheet **14** and recording sheet **11**.

In FIG. **4**, a reference numeral **24** designates a motor for conveying the recording sheet which rotatively drives the platen roller **12** to convey the recording sheet **11** in the direction indicated by an arrow b which is opposite to the direction indicated by an arrow a; **25**, also a motor for conveying ink sheet to convey the ink sheet **14** in the direction indicated by an arrow a by rotating a capstan roller **71** and a pinch roller **72**; **26** and **27**, transmission gears to transmit the rotation of the motor **24** for conveying recording sheet to the platen roller **12**; **73** and **74**, transmission gears to transmit the rotation of the motor **25** for conveying ink sheet to the capstan roller **71**; and **75**, a sliding clutch unit.

Here, by setting the ratio between gears **74** and **75** so as to make the length of the ink sheet **14** taken up by the winding roller **18** driven by the rotation of a gear **75***a* longer than the length of ink sheet conveyed by the capstan roller **71**, the ink sheet **14** having been conveyed by the capstan roller **71** is reliably taken up by the winding roller **18**. Then, an amount equivalent to the difference between the amount of ink sheet **14** taken up by the winding roller **18** and that of ink sheet **14** conveyed by the capstan roller **71** is absorbed by the sliding clutch unit **75**. In this way, it is possible to restrict the fluctuation of the speed (amount) to convey ink sheet **14** caused by the changing diameter of the winding roller **18** as the winding advances.

FIG. **1** is a diagram showing the electrical connection between the control unit **101** and the recording unit **102** in a facsimile apparatus according to the present embodiment, and the unit which is common in the other figures is designated by the same reference number.

The thermal head **13** is a line head. Then, this thermal head **13** comprises a shift register **130** for inputting a one-line portion of the serial recording data **43***a* from the control unit **101** in synchronism with a shift clock **43***b* to retain such data; a latch circuit **131** for latching data in the shift register **130** by a latch signal **44**; and a heat generating element **132** comprising a heat resistive unit for one line portion. Here, the heat resistive element **132** is divided into m blocks indicated by numerals **132-1** to **132-***m* for driving.

Also, a reference numeral **133** designates a temperature sensor installed on the thermal head **13** for detecting the temperature of thermal head **13**. The output signal **42** of this temperature sensor **133** is inputted into the aforesaid CPU **113** after its A/D conversion having been executed in the control unit **101**. Thus, the CPU **113** detects the temperature of the thermal head **13** to adjust the amplitude of the strobe signal **47** or the driving voltage of the thermal head **13** and changes the energy applied to the thermal head **13** in accordance with the characteristics of the ink sheet **14**.

A reference numeral **134** designates a black dot counter to count the black dot numbers in one line, and **43***c*, a counter

clear signal output from the control unit **101** to reset the value of the counter **134** to its zero position. When the shift clock **43***b* is output, this black dot counter **134** increments its counting value by 1 if the recording data **43***a* is a black data "1". This counting value is inputted into the control unit **101** through a signal line **134***a*. Therefore, the control unit **101** is allowed to detect the numbers of the black dot data contained in the recording data of one line which is about to be recorded when the black dot numbers are inputted thereto through the signal line **134***a* after the recording data of a one line portion has been transferred to the thermal head **13**.

A reference numeral **116** designates a programmable timer. Its timing is set by the CPU **113**, and when the timer is instructed to start its timing, the timer starts counting the time for the CPU **113** to output interrupt signals, time-out signals, and the like at each time indicated respectively.

In this respect, the characteristics (kinds) of the ink sheet **14** may be discriminated by the use of the aforesaid switch **103***a* in the operational unit **103** or the detection of marks and others printed on the ink sheet **14**, or the detection of marks, cut-off, projection or the like provided for a cartridge and the like.

A reference numeral **46** designates a driver to receive the driving signal for the thermal head **13** from the control unit **101** to output the strobe signal **47** to cause the thermal head **13** to be driven by a unit of each block. In this respect, the driver **46** enables the energy applied to thermal head **13** to be changed by adjusting the voltage output to the source line **45** which supplies electric current to the heat generating element **132** of the thermal head **13** in accordance with an instruction from the control unit **101**. A reference numeral **36** designates a driver including a motor for driving cutter to enable cutters **15** to be engaged for cutting; **39**, a motor for exhausting sheet to drive exhaust sheet rollers **16**.

Reference numerals **35**, **48** and **49** designate motor drivers to drive the motor **39** for exhausting sheet, motor **24** for conveying recording sheet, and motor **25** for conveying ink sheet, respectively. In this respect, the motor **39** for exhausting sheet, motor **24** for conveying recording sheet, and motor **25** for conveying ink sheet are stepping motors in the present embodiment. These motors, however, are not limited thereto, and for example, DC motors or the like may also be usable.

<Description of Recording Processing (FIG. **1**–FIG. **6**)>

FIG. **5**A-**1**, FIG. **5**A-**2** and FIG. **5**B are flowcharts showing image recording processing for a one-page portion in a facsimile apparatus according to the present embodiment. The control program for executing this process is stored in the ROM **114** in control unit **101**.

This processing is started when the image recording operation is ready to start with the one-line portion of the image data stored in the line memory **110** for an image to be recorded. Here, it is assumed that the control unit **101** has discriminated by the functions of the switch **103***a* and others that the multi-ink sheet is installed.

First, at the step **S1**, the black dot counter **134** is cleared to the value "0" by the counter clear signal **43***c*. Then, at the step **S2**, the value of the timer **116** is cleared to prepare for timing the recording interval. Subsequently, the process proceeds to the step **S3** to output by serial signals the recording data of a one line portion to the shift register **130**. When the transfer of the recording data of the one line portion has been completed, a latch signal **44** is output at the step **S4** to store the recording data of the one line portion in the latch circuit **131**. Then, the process proceeds to the step **S5** to input the black dot numbers, which have been transferred to the thermal head **13**, into the control unit **101** through the signal line **134***a* for its storage in the black dot number memory **117** in the RAM **115**.

Next, the process proceeds to the step **S6** to cause the motor **25** for conveying ink sheet to be driven to convey the ink sheet **14** for a 1/n line portion. More precisely, as shown in a timing chart shown in FIG. **6**, which will be described later, the conveyance driving for the ink sheet **14** is started by the timing just before each block of the thermal head **13** is energized, and the excitation phase of the motor **25** for conveying ink sheet is switched. Then, the process proceeds to the step **S7** to convey the recording sheet for the one portion. In this case, too, the excitation phase of the motor **24** for conveying recording sheet is switched by the timing just before the heat generating elements **132-1** and **132-3** of the thermal head **13** are energized to convey the recording sheet **11** as described in FIG. **6** in detail.

In this respect, the length of the one line in the subscanning direction (the conveying direction of the recording sheet) is set for approximately (1/7.7) mm in the facsimile apparatus according to the present embodiment, and the conveying amounts of the recording sheet **11** and ink sheet **14** are defined by changing the excitation pulse numbers of the motor **24** for conveying recording sheet and motor **25** for conveying ink sheet, respectively.

Thus, the process proceeds to the step **S8** to allow one of the blocks of the heat generating element **132** of the thermal head **13** to be energized to perform the image recording, and at the step **S9**, whether or not the entire blocks of the heat generating element **132** of the thermal head **13** is examined. If the entire blocks have not yet been energized, the process proceeds to the step **S10**. If the entire blocks of the thermal heat **13** have been energized, the process proceeds to the step **S16**.

At the step **S10**, whether or not the generation of the next line data has been completed (whether the receiving of the signals for the next line as well as its decoding has been completed or not) is examined. If the generation of the next line data has been completed, the process proceeds to the step **S11**. Otherwise, the process proceeds to the step **S14**. At the step **S11**, whether the process is for the first one subsequent to the completion of the data generation or not is examined. If so, the process proceeds to the step **S12** to clear the black dot counter **134**. Then, proceeding to the step **S13**, the process is conducted so as to transfer the next line data to be recorded to the shift register **130** of the thermal head **13**. Also, in this way, the black dot numbers in that particular line are counted by the black dot counter **134**.

Here, at the step **S10**, if the generation of the next line data has not yet been completed, the process proceeds to the step **S14** to receive the signals for such line data for the decoding processing. Then, at the step **S15**, whether the time has elapsed to energize the black or not is examined. If the energizing time (approximately 1,200 μs) has not elapsed as yet, then the process returns to the step **S10**. If, however, the energizing time has elapsed the process returns to the step **S8** to execute the energizing processing for the next block. Here, in the present embodiment, the thermal head **13** is divided into four blocks (m=4) to be energized for its driving, and the required time for recording one line is approximately 5.0 ms (1,200 μs×4 blocks).

At the steps **S9**, when the entire blocks have been energized to perform the one line recording, the process proceeds to the step **S16** to examine whether or not the predetermined conditions are satisfied to convey the ink sheet **14** on the basis of the elapsed time since the completion of the recording of the last line information, which has been measured by the timer **116**, and the black dot numbers (the

value of the black dot number memory **117**) contained in the recorded line information. This predetermined condition will be described later in detail. If the predetermined conditions have been satisfied, the process proceeds to the step **S17** to drive the motor **25** for conveying ink sheet, so that the ink sheet **14** is conveyed excessively by an amount of ½ n line. On the other hand, if the predetermined conditions are not satisfied, the process proceeds to the step **S18** without any performance of conveying the ink sheet **14**.

At the step **S18**, whether a one-page portion image recording processing has been terminated or not is examined. If the one-page portion recording processing has not yet been terminated, the process proceeds to the step **S19**. On the other hand, if the one-page portion image recording has been terminated, the process proceeds to the step **S26** to convey the recording sheet **11** towards the exhaust roller **16** (**16***a* and **16***b*) by a predetermined amount. Then, at the step **S27**, the cutters **15** (**15***a* and **15***b*) are driven to engage for cutting the recording sheet **11** by the one-page unit. Subsequently, by the exhaust rollers **16**, the recording sheet **11** thus cut is exhausted to the outside of the apparatus and at the same time, at the step **S28**, the remaining recording sheet **11** is retracted for an amount equivalent to the distance between the thermal head **13** and the cutters **15** to terminate the recording processing for the one page.

If, meanwhile, the one-page portion image recording processing has not yet been terminated at the step **S18**, the process proceeds to the step **S19** to reset the timer **116** for measuring the recording intervals. Then, advancing to the step **S20**, the process is executed to examine whether or not the next line data has already been transferred to the thermal head **13**. If the transfer has been completed, the process returns to the step **S4** to repeat the execution of the aforesaid processing.

At the step **S20**, if the transfer of the next line data to the thermal head **13** has not been completed as yet, the process proceeds to the step **S21** to examine whether or not the generation of the next line data has been terminated. Then, if the generation has not been terminated, the process advances to the step **S22** to continue receiving the signals for the next line data and its decoding processing. At the step **S21**, if the generation of the next line data has been terminated, the process proceeds to the step **S23** to examine whether the current processing is the initial one subsequent to the generation of the next line data or not as in the case of the step **S11** as described earlier, and if the processing is an initial one, the black dot counter **134** is cleared at the step **S24** as in the case of the step **S12**. Then, the process proceeds to the step **S25** to transfer the next line data thus generated to the thermal head **13** and returns to the step **S4**.

<Description of Ink Sheet Conveyance Conditions>

FIG. **5**C is a view illustrating the conveyance conditions determined for the ink sheet **14** at the aforesaid step **S16**. FIG. **5**D is a flowchart showing the judgment processing at the aforesaid step **S16** and step **S17** and the conveyance processing of the ink sheet **14**. In this respect, the recording cycle in FIG. **5**C represents an elapsed time since the termination of the last line recording.

In FIG. **5**C, when the recording cycle t is 30 ms or less, the ink sheet **14** is not conveyed. Also, when the recording cycle t is 30 ms or more and 40 ms or less, the ink sheet **14** is conveyed excessively by the amount corresponding to a ½ of the conveyance length of the ink sheet defined for the current recording mode subsequent to the termination of the current line recording if the black dot numbers in the currently recorded line exceed 1,843 (this being a black rate of more than 90% in the case of a recording data in a B4 size). Thereafter, the black dot numbers for each of the recording cycles are mentioned lilkewise, and whether the ink sheet **14** should be conveyed excessively or not is decided on the basis of these conditions.

In FIG. **5**D, at the step **S30** at first, the timing value of the timer **116** is read to discriminate whether or not the recording cycle is 30 ms or less, and if the cycle is 30 ms or less, then the processing is terminated as it is. If the cycle is more than 30 ms, then the process advances to the step **S31** to examine whether or not the recording cycle is 40 ms or less. If the cycle is 40 ms or less, then the process proceeds to the step **S37** to examine whether or not the black dot numbers in the recording data in the currently recorded line exceed 1,843. If the black dot numbers are more than that number, the process advances to the step **S36** to convey the ink sheet **14** excessively by the amount corresponding to a ½ of the ink sheet conveyance length for a one line in the current conveyance mode (in the present embodiment, for example, a ½ n line). This step **S36** corresponds to the processing at the aforesaid step **S17**. In this respect, if the black dot numbers are 1,843 or less, no particular process is executed then.

If the recording cycle t exceeds 40 ms, the process proceeds to the step **S32** to examine whether or not the recording cycle is 60 ms or less. With the condition of 40 ms<t≦60 ms, the process advances to the step **S38** to examine whether or not the dot numbers stored in the black dot number member **117** is 1,331 or more. If the dot numbers are 1,331 or more, the ink sheet is conveyed at the step **S37**. If the numbers are less than 1,331, no particular processing is executed then. Likewise, if the recording cycle t is in the condition of 60 ms<t≦250 ms, the process proceeds from the step **S33** to the step **S39** to examine whether or not the value of the black dot number memory **117** is 1,536 or more. If the value is 1,536 or more, the process advances to the step **S36**. Otherwise, the process returns as it is. Also, the recording cycle t is in the condition of 250 ms<t≦5,000 ms, the process advances from the step **S34** to the step **S40**, and if the black dot numbers are 1,024 or more, then the process proceeds to the step **S36**. Also, if the condition is of 500 ms<t, the process advances to the step **S35**, and if the black dot numbers are 512 or more, then the process proceeds to the step **S36** to convey the ink sheet **14** excessively.

In this respect, the judgment conditions thereby to decide whether or not the ink sheet **14** should be conveyed on the basis of these above-mentioned recording cycles and the black dot numbers in the corresponding one line have been obtained from the experimental results.

Hence, according to the present embodiment, when the predetermined conditions made up with the elapsed time since the completion of the recording of the last line information and the black dot numbers contained in the currently recorded one line are satisfied, the aforesaid ink sheet **14** is conveyed for a predetermined length, without conveying the recording sheet **11**, subsequent to the termination of the current line recording.

In this way, it is possible to improve the traveling ability of the ink sheet **11** as well as to minimize the force required for shearing ink from ink in the ink layer. Also, it is possible to improve the separation between the ink sheet **14** and recording sheet **11** when the ink sheet **14** and recording sheet **11** are conveyed for the next recording.

FIG. **6** is a timing chart showing the timing to energize the thermal head **13** in the image recording processing of the present embodiment and the timing to convey the ink sheet **14** and recording sheet **11**. Here, the heat resistive unit **132** of the thermal head **13** is divided into four blocks to be

energized as described earlier, and each of the strobe signals **1** to **4** corresponds to each of the block energizing signals of the heat resistive unit **132** of the thermal head **13**.

Here, in this respect, the fine mode recording operation is represented, and when the pulses are generated to indicate the timings to convey the ink sheet **14** and recording sheet **11**, the excitation phase (a ½ of a half step portion) of the respective motor is switched for the conveyance. Here, the recording sheet **11** is conveyed for (1/7.7) mm at two half steps while the ink sheet **14** is conveyed for (1/7.7 n) mm at four half steps, where n=5 in this respect.

The timing T1 indicates that the next line recording data have been transferred to the thermal head **13** completely, and that the next line recording can be executed. At the timing T1, the excitation phase of each motor is switched to convey the ink sheet **14** and recording sheet **11** and each of the motors is driven for a half step. The motors are actuated before the recording operation is started because there is a temporal delay between the switching of the excitation phases of the motors and the conveyance of the recording sheet **11** and ink sheet **14**.

Then, as indicated by a reference numeral **61**, the recording is performed for a one line. The timing T2 indicates that the next line recording data has been transferred to the thermal head **13**, and that the recording for the next line (**63**) is ready. At this time, the judgment is made on the basis of the recording cycle (a period from T1*a* to T2*a*), which is the time having elapsed from the termination of the one line recording to the next line recording becoming ready, and the black dot numbers contained in the line information recorded by the recording processing **63**. Now, it is assumed, for example, that the elapsed time from the timing T1*a* to the timing T2 is 30 ms or less. Then, any excessive conveyance of the ink sheet **14** is not executed after the termination of the recording processing **63**.

On the other hand, in the recording processing **65** which begins at the timing T3, the ink sheet **14** is conveyed for a ½ n line portion [in the present embodiment, (½)×(1/7.7)×1/n) mm] subsequent to the termination of the recording processing **65** as represented by a numeral **66**, provided that the elapsed time is at least 30 ms or more from the termination point T2*a* of the last line recording processing **63** to the starting time T3 of the current line recording operation **65**, and that the black dot numbers in the one line recorded by the recording processing **65** satisfy the condition shown in FIG. **5**C.

Hence, according to the present embodiment, there is an effect that the ink sheet and recording medium can be separated reliably after the image recording by conveying the ink sheet for a predetermined length subsequent to the termination of the current line recording on the basis of the time interval after the termination of the last line recording as well as of black dot numbers contained in the line information recorded on the current line.

In this respect, the ink sheet conveyance after the termination of the current line recording is controlled on the basis the elapsed time after the termination of the last line recording and black dot numbers contained in the current line. In addition to this, it is also possible to control the ink sheet conveyance after the termination of the current line recording in accordance with the difference between the black numbers in the last line and the current line.

FIG. **7** is a block diagram showing the electrical connection between the control unit and recording unit in a facsimile apparatus according to a second embodiment of the present invention. In this respect, the schematic structure of the facsimile apparatus in the present embodiment is the same as the structure shown in FIG. **2** through FIG. **4**, and the description thereof will be omitted.

In FIG. **7**, the constituents having the same reference numerals appearing in FIG. **1** are the same constituents, and what differs in the present embodiment from the one in FIG. **1** is that there is further provided an area in the RAM **115** for storing the black dot number data of the last line.

<Description of Recording Processing in the Present Embodiment (FIG. **2**–FIG. **4**, and FIG. **7**–FIG. **9**)>

FIG. **8**A-**1**, FIG. **8**A-**2** and FIG. **8**B are flowcharts showing image recording processing for a one-page portion in a facsimile apparatus according to the present embodiment. The control program for executing this process is stored in the ROM **114** in the control unit **101**.

This processing is started when the image recording operation is ready to start with the one-line portion of the image data stored in the line memory **110** for an image to be recorded. Here, it is assumed that the control unit **101** has discriminated by the functions of the switch **103***a* and others that the multi-ink sheet is installed.

First, at the step S**101**, the black dot counter **134** is cleared to the value "0" by the counter clear signal **43***c* and at the same time, the black dot number memory **117** of the RAM **115** and a last line black dot number memory **118** are cleared. Then, at the step S**102**, the value of the timer **116** is cleared to prepare for timing the recording interval. Subsequently, the process proceeds to the step S**103** to output in serial the recording data of a one line portion to the shift register **130**. When the transfer of the recording data of the one line portion has been completed, a latch signal **44** is output at the step S**104** to store the recording data of the one line portion in the latch circuit **131**.

Then, the process proceeds to the step S**105** to transfer the value of the black dot number memory **117** to the last line black dot number memory **118** and at the same time, to input the black dot numbers in the one line data transferred to the thermal head **13** through the signal line **134***a* for its storage in the black dot number memory **117** of the RAM **115**. Hence, in the black dot number memory **117**, the black dot numbers in a proceeding one line to be recorded then are stored while in the last line black dot number memory **118**, the black dot numbers having been recorded in the immediately preceding one line are stored.

Next, the process proceeds to the step S**106** to cause the motor **25** for conveying ink sheet to be driven to convey the ink sheet **14** for a 1/n line portion. More precisely, as shown in a timing chart shown in FIG. **9**, which will be described later, the conveyance driving for the ink sheet **14** is started by the timing just before each block of the thermal head **13** is energized, and the excitation phase of the motor **25** for conveying ink sheet is switched. Then, the process proceeds to the step S**107** to convey the recording sheet **11** for the one portion. In this case, too, the excitation phase of the motor **24** for conveying recording sheet is switched by the timing just before the heat generating elements **132-1** and **132-3** of the thermal head **13** are energized to convey the recording sheet **11** as described in FIG. **9** in detail.

In this respect, the length of the one line is set for approximately 1/7.7 mm in the facsimile apparatus according to the present embodiment, and the conveying amounts of the recording sheet **11** and ink sheet **14** are defined by changing the excitation pulse numbers of the motor **24** for conveying recording sheet and motor **25** for conveying ink sheet, respectively.

Thus, the process proceeds to the step S**108** to allow one of the blocks of the heat generating element **132** of the thermal head **13** to be energized to perform the image

recording, and at the step S109, whether or not the entire blocks of the heat generating element 132 of the thermal head 13 is examined. If the entire blocks have not yet been energized, the process proceeds to the step S110. If the entire blocks of the thermal head 13 have been energized, the process proceeds to the step S116.

At the step S110, whether or not the generation of the next line data has been completed (whether the receiving of the signals for the next line as well as its decoding has been completed or not) is examined. If the generation of the next line data has been completed, the process proceeds to the step S111. Otherwise, the process proceeds to the step S114. At the step S111, whether the process is for the first one subsequent to the completion of the data generation or not is examined. If so, the process proceeds to the step S112 to clear the black dot counter 134. Then, proceeding to the step S113, the process is conducted so as to transfer the next line data to be recorded to the thermal head 13. In this way, the black dot numbers in that particular line are counted by the black dot counter 134.

Here, at the step S110, if the generation of the next line data has not yet been completed, the process proceeds to the step S114 to receive the signals for such line data for the decoding processing. Then, at the step S115, whether the time has elapsed to energize the black or not is examined. If the energizing time (approximately 1,200 μs) has not elapsed as yet, then the process returns to the step S110. If, however, the energizing time has elapsed the process returns to the step S108 to execute the energizing processing for the next block. Here, in the present embodiment, the thermal head 13 is divided into four blocks (m=4) to be energized for its driving, and the required time for recording one line is approximately 5.0 ms (1,200 μs×4 blocks).

At the steps S109, when the entire blocks have been energized to perform the one line recording, the process proceeds to the step S116 to examine the elapsed time since the completion of the recording of the last line information, which has been measured by the timer 116, the black dot numbers (the value of the black dot number memory 117) recorded in the current line, and the value obtainable by subtracting the black dot numbers in the last line (the value of the memory 118) from the black dot numbers in the currently recorded line (the value of the memory 117) to judge whether or not these values are more than the predetermined values required to satisfy the predetermined conditions for conveying the ink sheet 14. The predetermined conditions in this respect will be described later in detail. If the predetermined conditions are satisfied, then the process proceeds to the step S117 to drive the motor 25 for conveying ink sheet to convey the ink sheet 14 excessively for a ½ n line. On the other hand, if the predetermined conditions are not satisfied, the process advances to the step S118 without conveying the ink sheet 14.

At the step S118, whether a one-page portion image recording processing has been terminated or not is examined. If the one-page portion recording processing has not yet been terminated, the process proceeds to the step S119. On the other hand, if the one-page portion image recording has been terminated, the process proceeds to the step S126 to convey the recording sheet 11 towards the exhaust roller 16 (16*a* and 16*b*) by a predetermined amount. Then, at the step S127, the cutters 15 (15*a* and 15*b*) are driven to engage for cutting the recording sheet 11 by the one-page unit. Subsequently, by the exhaust rollers 16, the recording sheet 11 thus cut is exhausted to the outside of the apparatus and at the same time, at the step S128, the remaining recording sheet 11 is retracted for an amount equivalent to the distance between the thermal head 13 and the cutters 15 to terminate the recording processing for the one page.

If, meanwhile, the one-page portion image recording processing has not yet been terminated at the step S118, the process proceeds to the step S119 to reset the timer 116 for measuring the recording intervals. Then, advancing to the step S120, the process is executed to examine whether or not the next line data has already been transferred to the thermal head 13. If the transfer has been completed, the process returns to the step S104 to repeat the execution of the aforesaid processing.

At the step S120, if the transfer of the next line data to the thermal head 13 has not been completed as yet, the process proceeds to the step S121 to examine whether or not the generation of the next line data has been terminated. Then, if the generation has not been terminated, the process advances to the step S122 to continue receiving the signals for the next line data and its decoding processing. At the step S121, if the generation of the next line data has been terminated, the process proceeds to the step S123 to examine whether the current processing is the initial one subsequent to the generation of the next line data or not as in the case of the step S111 as described earlier, and if the processing is an initial one, the black dot counter 134 is cleared at the step S124 as in the case of the step S112. Then, the process proceeds to the step S125 to transfer the next line data thus generated to the thermal head 13 and returns to the step S104.

<Description of Ink Sheet Conveyance Conditions>

FIG. 8C is a view illustrating the conveyance conditions determined for the ink sheet 14 at the aforesaid step S116. FIG. 8D is a flowchart showing the judgment processing at the aforesaid step S116 and step S117 and the conveyance processing of the ink sheet 14. In this respect, the recording cycle in FIG. 8C represents an elapsed time since the termination of the last line recording.

In FIG. 8C, when the recording cycle t is 30 ms or less, the ink sheet 14 is not conveyed. Also, when the recording cycle t is 30 ms or more and 40 ms or less, the ink sheet 14 is conveyed excessively by the amount corresponding to a ½ of the conveyance length of the ink sheet defined for the current recording mode if the black dot numbers in the currently recorded line exceed 1,843 (this being a black rate of more than 90% in the case of a recording data in a B4 size). Thereafer, the black dot numbers for each of the recording cycles are mentioned likewise, and whether the ink sheet 14 should be conveyed excessively or not is decided on the basis of these conditions. Also, if the current condition does not conform to any one of these conditions, then the black dot numbers recorded in the last line (the value of the last line black dot number memory 118) are subtracted from the black dot numbers recorded in the current line (the value of the black dot number memory 117), and if the value thus obtained is 512 or more, the ink sheet 14 is conveyed excessively.

Now, this judgment processing will be described.

In FIG. 8D, at the step S130 at first, the timing value of the timer 116 is read to discriminate whether or not the recording cycle is 30 ms or less, and if the cycle is 30 ms or less, the process advances to the step S141 to obtain the difference between the black dot numbers recorded in the current line and the black dot numbers recorded in the last line, and to terminate the processing as it is if the value thus obtained is less than 512. If, however, the difference is 512 or more, the process proceeds to the step S136. Then, at the step S136, the ink sheet 14 is conveyed excessively by the amount corresponding to a ½ of the ink sheet conveyance

length for a one line in the current conveyance mode (in the present embodiment, for example, a ½ n line). This step **S136** corresponds to the processing at the aforesaid step **S117**. In this respect, as a typical example to satisfy the conditions at the step **S141**, there may be conceivable a case where the last line recording has been for ordinary characters and the like and the current line recording is for a horizontal line for a ruled mark or the like. With the processing at this step, however, it is possible to prevent the adhesion of the ink sheet **14** to the recording sheet **11** which is apt to occur in recording the horizontal line for the ruled mark.

On the other hand, at the step **S130**, if the recording cycle is 30 ms or more, the process proceeds to the step **S131** to examine whether or not the recording cycle is 40 ms or less. If the recording cycle is less than 40 ms, then the process advances to the step **S137** to examine whether or not the black dot numbers of the recording data in the current line is 1,843 or more, and if the black dot numbers exceeds that number, the proceeds to the step **S136**. If, however, the black dot numbers are less than 1,843, the process advances to the step **S141**.

If the recording cycle t exceeds 40 ms at the step **S131**, then the process proceeds to the step **S132** to examine whether or not the recording cycle is 60 ms or less. With the condition of 40 ms<t≦60 ms, the process advances to the step **S138** to examine whether or not the dot numbers stored in the black dot number memory **117** is 1,331 or more. If the dot numbers are 1,331 or more, the ink sheet is conveyed at the step **S136**. If the numbers are less than 1,331 the process proceeds to the step **S141**. Likewise, if the recording cycle t is in the condition of 60 ms<t≦250 ms, the process proceeds from the step **S133** to the step **S139** to examine whether or not the value of the black dot number memory **117** is 1,536 or more. If the value is 1,536 or more, the process advances to the step **S136**. Otherwise, the process proceeds to the step **S141**, Also, the recording cycle t is in the condition of 250 ms<t≦5,000 ms, the process advances from the step **S134** to the step **S140**, and if the black dot number are 1,024 or more, then the process proceeds to the step **S136**. Also, if the condition is of 500 ms<t, the process advances to the step **S135**, and if the black dot number are 512 or more, then the process proceeds to the step **S136** to convey the ink sheet **14** excessively.

In this respect, the judgment conditions thereby to decide whether or not the ink sheet **14** should be conveyed on the basis of the above-mentioned recording cycles and the black dot numbers recorded in the corresponding one line, and of the difference between the black dot numbers in the current line and the recorded black dot numbers in the last line have been obtained from the experimental results.

Hence, according to the present embodiment, when the predetermined conditions made up with the elapsed time since the completion of the recording of the last line information and the black dot numbers contained in the currently recorded one line are satisfied, or when the black dot numbers recorded in the current line are greater than the black dot numbers recorded in the last line by 512 or more, the aforesaid ink sheet **14** is conveyed for a predetermined length, without conveying the recording sheet **11**, subsequent to the termination of each recording in the current line.

In this way, it is possible to improve the traveling ability of the ink sheet **11** as well as to minimize the force required for shearing ink from ink in the ink layer. Also, it is possible to improve the separation between the ink sheet **14** and recording sheet **11** when the ink sheet **14** and recording sheet **11** are conveyed for the next recording.

FIG. **9** is a timing chart showing the timing to energize the thermal head **13** in the image recording processing of the present embodiment and the timing to convey the ink sheet **14** and recording sheet **11**. Here, the heat resistive unit **132** of the thermal head **13** is divided into four blocks to be energized as described earlier, and each of the strobe signals **1** to **4** corresponds to each of the block energizing signals of the heat resistive unit **132** of the thermal head **13**.

Here, in this respect, the fine mode recording operation is represented, and when the pulses are generated to indicate the timings to convey the ink sheet **14** and recording sheet **11**, the excitation phase (a ½ of a half step portion) of the respective motor is switched for the conveyance. Here, the recording sheet **11** is conveyed for (1/7.7) mm at two half steps while the ink sheet **14** is conveyed for (1/7.7 n) mm at four half steps, where n=5 in this respect.

The timing **T1** indicates that the next line recording data have been transferred to the thermal head **13** completely, and that the next line recording can be executed. At the timing **T1**, the excitation phase of each motor is switched to convey the ink sheet **14** and recording sheet **11** and each of the motors is driven for a half step. The motors are actuated before the recording operation is started because there is a temporal delay between the switching of the excitation phases of the motors and the conveyance of the recording sheet **11** and ink sheet **14**.

Subsequently, as indicated by a reference numeral **61**, the recording is performed for a one line. The timing **T2** indicates that the next line recording data has been transferred to the thermal head **13**, and that the recording for the next line (**63**) is ready. At this time, the judgment is made on the basis of the recording cycle (a period from the timing **T1***a* to terminate the recording processing **61** to **T2**), and the black dot numbers contained in the line information to be recorded, or the value obtainable by subtracting the black dot numbers recorded in the recording processing **61** from the black dot numbers to be recorded in the recording processing **63**. Here, it is assumed, for example, that the elapsed time from the timing **T1***a* to the timing **T2** is 30 ms or less and that the aforesaid difference in the black dot numbers is less than 512, any excessive conveyance of the ink sheet **14** is not executed after the termination of the recording processing **61**.

On the other hand, in the recording operation which begins at the time **T3**, the ink sheet **14** is conveyed for a ½ n line portion [in the present embodiment, (½)×(1/7.7)×1/n) mm] subsequent to the termination of the recording processing **65** as represented by a numeral **66**, provided that the elapsed time is at least 30 ms or more from the termination point **T2***a* of the recording processing **63** to the starting time **T3** of the next recording operation **65**, and that the black dot numbers in the one line recorded by the recording processing **65** satisfy the condition shown in FIG. **5**C.

For the timing **T4** to start the next recording processing **68**, the period from the timing **T3***a* for the termination of the last line recording to the **T4** is short (less than 30 ms), and the conditions represented in FIG. **8**C are not satisfied. Accordingly, the excessive conveyance of the ink sheet **14** is not executed after the recording processing **68**. On the other hand, in the recording processing **70**, even if the period from the timing **T4***a* for the termination of the last line recording processing **68** to the starting timing **T5** for recording processing **70** is short (less than 30 ms) and the black dot numbers to be recorded in the recording processing **70** are 1,800 (<1,843), for example, the ink sheet **14** is conveyed for a predetermined amount of [(½)×(1/7.7)×(1/n) mm] subsequent to the recording processing **70** as designated by a

numeral **71**, provided that the black dot numbers recorded in this recording processing **70** is greater than the black dot numbers recorded in the last line recording process **68** by 512 or more.

Hence, according to the present embodiment, there is an effect that the ink sheet and recording medium can be separated more assuredly after the image recording by conveying the ink sheet for a predetermined length subsequent to the termination of the current line recording on the bais of the time interval after the termination of the last line recording as well as of the black dot numbers contained in the recorded line information or the difference between the black dot numbers in the last line and the black dot numbers in the current line.

Here, in the present embodiment, although the excessive conveyance of the ink sheet **14** subsequent to the termination of the current line recording is executed for a constant amount, the present invention is not limited thereto. This length of conveyance of the ink sheet **14** may be variable on the basis of the time interval after the termination of the last line recording, the black dot numbers contained in the recorded line information, the difference between the black dot numbers in the last line and the black dot numbers in the current line and others.

According to the present embodiment as described above, the ink sheet **14** and recording sheet **11** can be separated more assuredly in a thermal transfer printer by conveying the ink sheet **14** for a predetermined length subsequent to the termination of the current line recording on the basis of the time interval after the termination of the last line recording as well as of the black dot numbers contained in the recorded line information or the difference between the black dot numbers in the last line and the black dot numbers in the current line after the termination of the current line recording.

Also, according to the previous embodiment and the present embodiment, the ink about **14** can be separated from the recording sheet **11** reliably in a facsimile apparatus in response to the variations in the recording cycle caused by the changes in the recording modes such as standard, fine, and superfine. As a result, these embodiments are efficiently applicable to the facsimile apparatus and other recording apparatuses in which there is a possibility that the recording cycle is unevenly extended depending on the temporal intervals between the one-line image data or on its decoding processing time thereof.

Here, in the aforesaid two embodiments, the structure is arranged to control the ink sheet conveyance on the basis of the black dot numbers and the recording cycle, but it may be possible to control the energy which produces effects on the ink sheet on the basis of the black dot numbers.

FIG. **10** is a block diagram showing the electrical connection between the control unit and recording unit in a facsimile apparatus according to the present embodiment. In this respect, the schematic structure and others of the facsimile apparatus in the present embodiment are the same as those appearing in FIG. **2** though FIG. **4**. Therefore, the descriptions thereof will be omitted.

In FIG. **10**, those having the same reference marks as in FIG. **1** are the same constituents, and what differs in the present embodiment from the one shown in FIG. **1** is that the flag F1 and power down flag PWDF, which will be described later, are provided in the RAM **115**.

<Description of Recording Processing in the Present Embodiment (FIG. **2**–FIG. **4** and FIG. **10**–FIG. **12**)>

FIG. **11** is a flowchart showing the recording processing for a one-page portion in a facsimile apparatus according to the present embodiment. The control program for executing this processing is stored in the ROM **114** in the control unit **101**.

This processing is started when the recording operation is ready to start with the one-line portion of the image data stored in the line memory **110** for an image to be recorded. Here, it is assumed that the control unit **101** has discriminated by the functions of the switch **103***a* and others that the multi-ink sheet **14** is installed.

At the step **S201** at first, the power down flag (PWDF), which is provided in the RAM **115** to indicate that the power of the energy applied to the thermal head **13** is lowered (power down) for recording, is cleared to "0". Then, proceeding to the step **S202**, the process causes a clear pulse to be output in the signal line **43***c* to clear the black dot number counter **134**. Subsequently, the process proceeds to the step **S203** to output by serial signals the recording data of a one line portion to the shift register **130**. When the transfer of the recording data of the one line portion has been completed, a latch signal **44** is output at the step **S204** to store the recording data of the one line portion in the latch circuit **131**. Then, the process proceeds to the step **S205** to input the black dot numbers of the black dot number counter **134** through the signal line **134***a*. Hence, the black dot numbers in a one line to be recorded next are inputted.

At the step **S206**, the motor **25** for conveying ink sheet is driven to convey the ink sheet **14** for a 1/n line portion. Then, at the step **S207**, the motor **24** for conveying recording sheet **11** is driven to convey the recording sheet for a one line portion. In this respect, the length of this one line portion in the facsimile apparatus of the present embodiment is set at approximately (1/7.7) mm, and the conveying amounts of the recording sheet **11** and ink sheet **14** can be set respectively by changing the excitation pulse numbers of the motor **24** for conveying recording sheet and motor **25** for conveying ink sheet.

Now, advancing to the step **S208**, the process executes the examination of whether or not the black dot numbers which have been inputted at the step **S205** in one line to be recorded next are 614 or more, and if the black dot numbers are 614 or more, the process proceeds to the step **S209** to examine whether the next recording mode is a recording in the standard more or not. In the case of the standard mode, the process advances to the step **S210** to set "3" to the PWDF in order to lower the energy applied to the thermal head **13** for recording the next line and subsequent three lines, and then advances to the step **S216**. This processing is needed because the conveying length of the recording sheet **11** in the subscanning direction becomes longer in the case of the standard mode, and the energy applied to the subsequent three lines including that line should be lowered at the time of recording in order to prevent the adhesion of the ink sheet **11** to the recording sheet **14** subsequent to recording a line contained more black dot numbers than the predetermined value. In this respect, if the recording is not in the standard mode at the step **S209**, i.e., if it is in the fine mode, the process proceeds to the step **S213** to perform the recording without lowering the energy applied to the thermal head **13**. This is possible because the conveying distances of the recording sheet **11** and ink sheet **14** in the subscanning direction during the period of recording each line are short in the fine mode, enabling the recording to be performed with a slight adhesion of the ink sheet **14** to the recording sheet **11** even without lowering the applied energy to the thermal head **13**.

On the other hand, if the black dot numbers are less than 614 at the step **S208**, the process proceeds to the step **S211**

to examine whether the value of the PWDF is "0" or not. If the value is "0", the process advances to the step **S213**. If the value is not "0", it proceeds to the step **S212** to decrement the PWDF value by 1, and then advances to the step **S216**.

At the step **S213**, the flag **F1** of the RAM **115** (this flag **F1** being a flag to indicate the destination for the process to return from the step **S224**) is turned on. Then, at the step **S214**, one of the blocks of the heat resistive unit **132** is energized to perform an image recording. At this juncture, the temperature of the thermal head **13** is detected on the basis of the signals from the temperature sensor **133** to change the pulse width of the strobe signal **47** applied to the thermal head **13** in response to the temperature thus detected. Here, the pulse width of the strobe signal **47** at that time is given as **P1**. In the meantime, at the step **S216**, the flag **F1** is turned on and at the step **S217**, one of the blocks of the thermal head **213** is energized to perform the recording the same as the step **S214**. In this respect, the pulse width of the strobe signal **47** applied to the thermal head **13** at that time is given as **P1/2**. This is necessary because whereas each of the blocks of the thermal head **13** is energized only once for recording one line at the time of the fine mode recording, each of the blocks of the thermal head **13** is energized twice for recording one line at the time of the standard mode recording. In this case, since the thermal head **13** is divided into four blocks, a total of eight energizings is required to perform the one line recording.

Now, the process, proceeding to the step **S215**, to examine whether or not the one line recording is completed subsequent to the entire blocks of the thermal head **13** having been energized. Here, the judgment is made on the basis of whether a total of four energizings has been executed in the case of the fine mode and a total of eight energizings, in the case of the standard mode, or not, respectively. At the step **S215**, if the entire blocks of the thermal head **13** have not been energized as yet, the process proceeds to the step **S218** to examine whether the recording data for the next line has been ready or not. If the data is ready, the process advances to the step **S220** to examine whether the next step is the first one immediately after the formation of the next line data, i.e., subsequent to the next line data having been produced, and if it is the first step, then the process advances to the step **S221** to clear the black dot number counter **134** by outputting a clear pulse to the counter **134** through the signal line **43***c*.

Then, the process proceeds to the step **S222** to transfer the next line data to the shift register **130** of the thermal head **13**, and at the step **S223**, to examine whether the energizing period (1,200 μs) has elapsed or not for the one block. If the energizing period has not elapsed yet, the process returns to the step **S218** to execute the aforesaid processing. In this respect, if the next line data has been produced at the step **S218**, the process advances to the step **S219** to decode the received signals for the next data line to convert them to the recording data. At the step **S223**, when the energizing period for the one line has elapsed, the process proceeds to the step **S224** to examine whether or not the flag **F1** is turned on, and if it is on, the process advances to the step **S213** while if it is off, to the step **S216**.

Subsequent to the one line recording having been completed by energizing the entire blocks at the step **S215**, the process proceeds to the step **S225** to examine whether a one-page image recording has been terminated or not. If the one-page image recording has been terminated, the process advances to the step **S229** to examine whether or not the entire image data for the next line has been transferred to the shift register **130** of the thermal head **13**. If the data has already been transferred, the process proceeds to **S204** to execute the aforesaid processing. If, on the contrary, the next line data has not yet been prepared at the step **S229**, the process proceeds to the step **S230** to examine whether or not the formation processing of the next line data has been terminated. If the formation has not been terminated as yet, the process advances to the step **S231** for decoding the facsimile image signals for the next line to produce its recording data.

When the next line data has been produced in this way, the process proceeds to the steps **S232** and **S233** to clear the black dot number counter **134** as at the steps **S220** and **S221**. Then, at the step **S234**, the process executes the transfer of the next line data to the shift register **130** of the thermal head **13**, and returns to the step **S204**. Here, in the present embodiment, since the thermal head **13** is divided into four blocks, the time required for recording one line is approximately 5 ms (1,200 μs×4) in the fine mode and approximately 10 ms (1,200 μs×8) in the standard mode.

Next, when an image recording for the one-page portion has been terminated at the step **S225**, the process advances to the step **S226** to convey the recording sheet **11** for a predetermined amount in the direction towards the exhaust sheet rollers **16***a* and **16***b*. Then, at the step **S227**, the cutters **15***a* and **15***b* are driven to engage to cut the recording sheet **11** into a unit of one page. Subsequently, at the step **S228**, the motor **24** for conveying recording sheet is driven to be reversely rotated to cause the recording sheet **11** to be retracted in a distance equivalent to the distance between the thermal head **13** and the cutter **15**. The cutting processing for a page-unit recording sheet **11** is executed in this way.

Hence, according to the present embodiment, it is designed to improve the separation of the ink sheet **14** and recording sheet **11** when the ink sheet **14** and recording sheet **11** are conveyed in such a manner that if the black dot numbers in a one line to be recorded next are more than the predetermined numbers, the energy applied to the thermal head **13** at the time of the next line recording and subsequent line recordings is reduced in response to the recording mode at that time so as to minimize the force required for shearing ink from ink in the ink layers.

FIG. **12** is a timing chart showing the timing to energize the thermal head **13** in the image recording processing of the present embodiment and the timing to convey the ink sheet **14** and recording sheet **11**. Here, the heat resistive unit **132** of the thermal head **13** is divided into four blocks to be energized. In this respect, each of the strobe signals **1** to **4** corresponds to each of the block energizing signals of the heat resistive unit **132** of the thermal head **13**. Here, the timing for the fine mode recording operation is represented, and the excitation phase of the corresponding motor is switched for only a (½) half step for each of the timing pulses for conveying the recording sheet **11** and ink sheet **14**. Here, the recording sheet **11** is conveyed for ($\frac{1}{7.7}$) mm at four half steps and the ink sheet **14** is also conveyed for ($\frac{1}{7.7}$) mm at four half steps. Here, in this respect, the value n which represents the conveying length of the recording sheet **11** against that of the ink sheet **14** is "5".

In FIG. **12**, a numeral **69** designates the timing for conveying the ink sheet **14** and recording sheet **11**, also, the numbers shown at the bottom of each of the recording operation timings for the respective line represent the black dot numbers recorded in that line. The timing **T1** indicates that the line **1** recording data has been transferred to the thermal head **13** completely, and that the recording in that line can be executed. At the timing **T1**, the excitation phase of each motor is switched to convey the ink sheet **14** and

recording sheet **11** and each of the motors is driven for a half step. The motors are actuated before the recording operation is started because there is a temporal delay between the switching of the excitation phases of the motors and the conveyance of the recording sheet **11** and ink sheet **14**. Subsequently, as indicated by a reference numeral **61**, the recording is performed for a one line. The black dot numbers to be recorded by this recording operation **61** are 250 and are less than 614 dots. Consequently, the energy applied to the thermal head **13** for recording this line is not reduced, and the pulse width of the strobe signal **47** is given as P1.

Next, the recording operation for line **2** designated by a numeral **62** is executed. The timing **T2** indicates that the line **2** recording data has been transferred to the thermal head **13**, and that the recording for that line can be executed. At this juncture, the black dot numbers to be recorded in the line **2** are 700 dots and are more than 614. Therefore, it is necessary to reduce the energy applied to the thermal head **13**. Because of this, the pulse width of the strobe signal **47** is reduced by ½ (P1/2). At the same time, when the three lines (line **3** to line **5**) following the line **2** are recorded, the energy applied to the thermal head **13** is reduced (the pulse width of the strobe signal **47** being (P1/2) for each recording irrespective of the black dot numbers to be recorded in each of those lines. Then, the black dot numbers to be recorded in the line **66** are 370 dots and are less than 614 dots. Therefore, the recording is executed with the usual width of the strobe signal **47** as in the case of the line **1**.

Here, in the aforesaid embodiment, although the recording is performed by energizing each block of the thermal head **13** once a time in the case of the fine mode recording, it may be possible to energize each of them plural times. Further, the motor **24** for conveying recording sheet is switched for four half steps in order to convey the ink sheet **14** or the recording sheet **11** for a (1/7.7) mm. However, the present invention is not limited thereto as a matter of course.

Also, in the aforesaid embodiment, the energy applied to the thermal head **13** is reduced at the time of recording the three lines subsequent to the line which includes 614 or more black dots. However, the line numbers can be defined arbitrarily. Further, in the aforesaid embodiment, although the applied energy is reduced only in the case of the standard mode, the energy may be reduced likewise in the case of the fine mode. Furthermore, while the reduction of the applied energy is effectuated by narrowing the width of the strobe pulse (in the example, the width being reduced by ½), the driving voltage to the thermal head **13** may be lowered instead, for example. Also, the standard value of the black dot numbers whereby to decide on the reduction of the energy applied to the thermal head **13** is defined as 614 dots. This value, however, can be set arbitrarily.

<Description of Recording Principle (FIG. **13**)>

FIG. **13** is a view showing a state of image recording in the above-mentioned three embodiments wherein an image is recorded by conveying the recording sheet **11** and ink sheet **14** in the opposite direction.

As shown in FIG. **13**, the recording sheet **11** and ink sheet **14** are pinched between the platen roller **12** and the thermal head **13**. The thermal head **13** is pressurized by a spring **21** under a given pressure against the platen roller **12**. Here, the recording sheet **11** is conveyed by the rotation of the platen roller **12** at a velocity Vp in the direction indicated by arrow b. Meanwhile, the ink sheet **14** is conveyed by the rotation of the motor **25** for conveying the ink sheet at a velocity V_1 in the direction indicated by an arrow a ($Vp=-nV_1$).

Now, when the heat resistive unit **132** of the thermal head **13** is heated by a current from the power source **105**, the portion **91** of ink sheet **14** indicated by slashed lines is heated. Here, a reference numeral **14***a* designates the base film of in sheet **14**; and **14***b*, the ink layer of the ink sheet **14**. When the heat resistive unit **132** is energized, the ink in the heated ink layer **91** is fused, and a portion thereof indicated by reference numeral **92** is transferred to the recording sheet **11**. This portion **92** to be transferred from the ink layer is almost equivalent to a 1/n of the portion of the ink layer indicated by the reference numeral **91**. At the time of this transfer, it is necessary to generate a shearing force against ink at the boundary line **93** of the ink layer **14***b* so that only the portion indicated by the reference numeral **92** is transferred to the recording sheet **11**. Here, in this respect, the reason why the ink sheet **14** and recording sheet **11** are conveyed in the directions opposite to each other is that by making the relative velocities of the ink sheet **14** and recording sheet **11** greater, the ink layer to be transferred is reliably separated from the ink sheet **14**.

<Description of Ink Sheet (FIG. **14**)>

FIG. **14** is a cross-sectional view of the ink sheet used for a multiprint according to the present embodiment. Here, the ink sheet is formed with four layers.

First, a second layer is the base film which is a member to support ink sheet **14**. In the case of multiprint, since the thermal energy is applied repeatedly to a same location, it is advantageous to use a high heat resistive aromatic polyamide film or a condenser sheet, but the conventional polyester film can also withsant the use. Although the thickness of the film should be as thin as possible for a better printing quality from the viewpoint of its role as a medium, the thickness of 3–8 μm is preferable from the viewpoint of the required strength.

A third layer is the ink layer containing an amount of ink which can be transferred to the recording paper (recording sheet) repeatedly for n times. The components thereof are resin such as EVA as adhesive, carbon black and nigrosine dye for coloring agent, and carnauba was, paraffin wax for binding agent. These elements are appropriately mixed as principle components to enable the layer to withstand a repeated application at a same location for n times. It is preferable to coat this layer in an amount of 4–8 g/m^2. However, such amount can be selected arbitrarily because its sensitivity and density differ depending on the coating amount.

A fourth layer is the top coating layer to prevent ink in the third layer from being transferred by pressure to the ink sheet at a location where no printing is executed. This layer is formed with a transparent wax or the like. Thus, the fourth layer which is transparent is the only portion to be transferred by pressure, and this prevents recording sheet from being stained. A first layer is the heat resistive coating layer to protect the second layer, which is the base film, from the heat of thermal head **13**. This is suited for the multiprint for which heat energy for n lines is often applied to a same portion (when black information continues), but its application is arbitrarily selective. Also, this is effectively applicable to a base film with comparatively low heat resistivity such as polyester film.

In this respect, the composition of the ink sheet **14** is not limited to the present embodiment. For example, the ink sheet can also be formed with a base layer and a porous ink retaining layer containing the ink which is provided at one end of the base layer, or having a fine porous netting structure provided on the base film to contain ink. Also, as the materials for base film, for example, film or paper formed with polyamide, polyethylene, polyester, polyvinyl chloride, triacetilene cellulose, nylon can be used. Further,

although the heat resistive coating is not necessarily required, its material may also be, for example, silicon resin, epoxy resin, fluorine resin, ethorocellulose, or the like.

In this respect, the heating method in a thermal transfer printer is not limited to the thermal head method using the aforesaid thermal head. The heating method using, for example, a current-carrying or laser transfer may also be employed.

Also, in the present embodiment, the description has been made of an example in which the thermal line head is used, but the application is not limited to this. A thermal transfer printer of the so-called serial type may also be employed. Further, although the description has been made of the multiprinting in the present embodiment, the application is not limited to this. An ordinary thermal transfer recording using a one-time ink sheet can also be employed as a matter of course. Furthermore, in the previous embodiment, although the description has been made of the case where the thermal transfer printer is applied to a facsimile apparatus, the application is not limited thereto and a thermal transfer recording apparatus according to the present invention can also be applied to a word processor, typewriter, copying machine, or the like.

Also, the recording medium is not limited to the recording sheet. If only a material is capable of accepting the transferred ink, cloth, plastic sheet or the like may be used as a recording medium. Also, the ink sheet is not limited to the rolled type as shown in the present embodiment. The ink sheet can be of a type such as stored in a housing which can be installed detachably in the main body of the recording apparatus, i.e., the so-called ink sheet cassette type which enables such a housing containing ink sheets to be mounted detachably as it is in the main body of the recording apparatus.

What is claimed is:

1. A thermal transfer recording apparatus for performing recording of an image on a recording medium by transferring ink contained in an ink sheet to said recording medium, comprising:

ink sheet conveyance means for conveying said ink sheet;

recording medium conveyance means for conveying said recording medium;

recording means for recording an image by a unit of line on said recording medium by activating said ink sheet, in accordance with a line recording information;

counting means for counting a number of black dots contained in a line recording information to be recorded by said recording means; and

control means for controlling an energy which activates said ink sheet to be reduced at a time of recording said recording information when a counting value of said counting means is more than a predetermined number,

wherein said control means reduces the energy which activates said ink sheet at a time of recording of an image of a line where the counting value of said counting means is more than a predetermined number and, in addition, an image of plural lines subsequent thereto.

2. A thermal transfer recording apparatus according to claim **1**, wherein said control means reduces the energy which activates said ink sheet at a time of recording of an image of a line where the counting value of said counting means is more than a predetermined number and, in addition, an image of plural lines subsequent thereto, when a length in a direction orthogonal to a line direction of said image of a line is a predetermined length.

3. A thermal transfer recording apparatus according to claim **2**, wherein said control means reduces the energy which activates said ink sheet at a time of recording of only an image of a line where the counting value of said counting means is more than a predetermined number, when the length in the direction orthogonal to the line direction of said image of a line is a predetermined length.

4. A thermal transfer recording apparatus according to one of claims **1–3**, wherein said ink sheet and said recording medium are conveyed in opposing directions.

5. A thermal transfer recording apparatus according to claim **4**, wherein said ink sheet transfers ink to a recording medium from a same location n times ($n \geqq 2$), and a length for conveying the ink sheet at a time of recording in a recording length L is L/n.

6. A thermal transfer recording apparatus according to one of claims **1–3**, wherein said ink sheet transfers ink to a recording medium from a same location n times ($n \geqq 2$), and a length for conveying the ink sheet at a time of recording in a recording length L is L/n.

7. A facsimile apparatus using a thermal transfer recording apparatus for performing recording of an image on a recording medium by transferring ink contained in an ink sheet to said recording medium, comprising:

communication means for receiving line image data;

ink sheet conveyance means for conveying said ink sheet;

recording medium conveyance means for conveying said recording medium;

recording means for recording a line image on said recording medium by activating said ink sheet being conveyed by said ink sheet conveyance means in accordance with the line image data received by said communication means;

counting means for counting a number of black dots contained in line image data to be recorded by said recording means; and

control means for controlling an energy which activates said ink sheet to be reduced when a counting value of said counting means is more than a predetermined number and said recording information is recorded by said recording means, wherein said control means reduces the energy which activates said ink sheet at a time of recording of an image of a line where the counting value of said counting means is more than a predetermined number and, in addition, an image of plural lines subsequent thereto.

8. A facsimile apparatus according to claim **7**, further comprising selecting means for selecting one of a plurality of recording modes including a standard recording mode and a fine recording mode, and wherein said control means reduces the energy which activates said ink sheet at a time of recording of an image of a line where the counting value of said counting means is more than a predetermined number and, in addition, an image of plural lines subsequent thereto, in the standard recording mode.

9. A facsimile apparatus according to claim **8**, wherein said control means reduces the energy which activates said ink sheet at a time of recording only an image of a line where the counting value of said counting means is more than a predetermined number in the fine recording mode.

10. A facsimile apparatus according to one of claims **7–9**, wherein said ink sheet and said recording medium are conveyed in opposing directions.

11. A facsimile apparatus according to claim **10**, wherein said ink sheet transfers ink to a recording medium from a same location n times ($n \geqq 2$), and a length for conveying the ink sheet at a time of recording in a recording length L is L/n.

12. A facsimile apparatus according to one of claims **7–9**, wherein said ink sheet transfers ink to a recording medium from a same location n times ($n \geqq 2$), and a length for conveying the ink sheet at a time of recording in a recording length L is L/n.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,530,470

DATED : June 25, 1996

INVENTOR(S) : TAKEHIRO YOSHIDA ET AL.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

TITLE PAGE:

AT [56] UNDER FOREIGN PATENT DOCUMENTS

"62-58917 1/1983 Japan" should read --62-58917 1/1987 Japan--

AT [57] IN THE ABSTRACT

Line 1, "performing the" should be deleted;
Line 4, "ink sheet" (first occurrence) should be deleted.

IN THE DRAWINGS:
AT SHEET 9, FIGURE 5D

"ERIOD" should read --PERIOD--.

AT SHEET 15, FIGURE 8D

"ERIOD" should read --PERIOD--.

COLUMN 1

Line 22, "the" should read --this--.

COLUMN 4

Line 3, "the second" should read --in the second--.

COLUMN 8

Line 61, "steps" should read --step--.

UNITED STATES PATENT AND TRADEMARK OFFICE

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PATENT NO. : 5,530,470

DATED : June 25, 1996

INVENTOR(S) : TAKEHIRO YOSHIDA ET AL.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

COLUMN 11

Line 38, "1/n)" should read --(1/n)--;
Line 56, "basis" should read --basis of--.

COLUMN 13

Line 34, "steps" should read --step--.

COLUMN 14

Line 45, "Thereafer," should read --Thereafter,--.

COLUMN 16

Line 46, "1/n)" should read --(1/n)--.

COLUMN 18

Line 54, "contained" should read --containing--.

COLUMN 22

Line 28, "withsant" should read --withstand--.

COLUMN 24

Line 5, "one" should read --any one--;
Line 12, "one" should read --any one--;

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,530,470

DATED : June 25, 1996

INVENTOR(S) : TAKEHIRO YOSHIDA ET AL.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

COLUMN 24 (cont'd)

Line 54, "one" should read --any one--;
Line 61, "one" should read --any one--.

Signed and Sealed this

Twenty-ninth Day of October 1996

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks